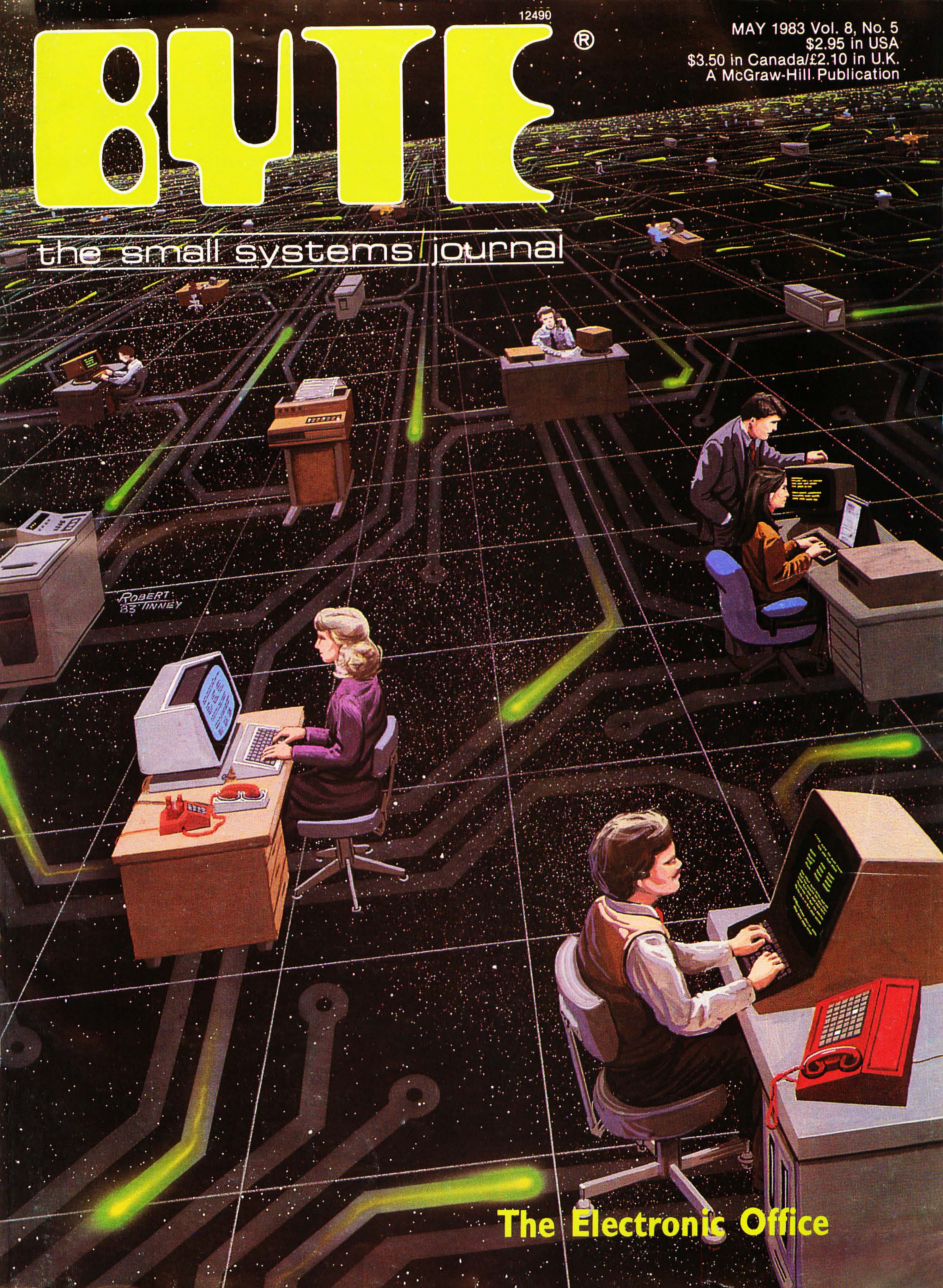


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Inside Apple

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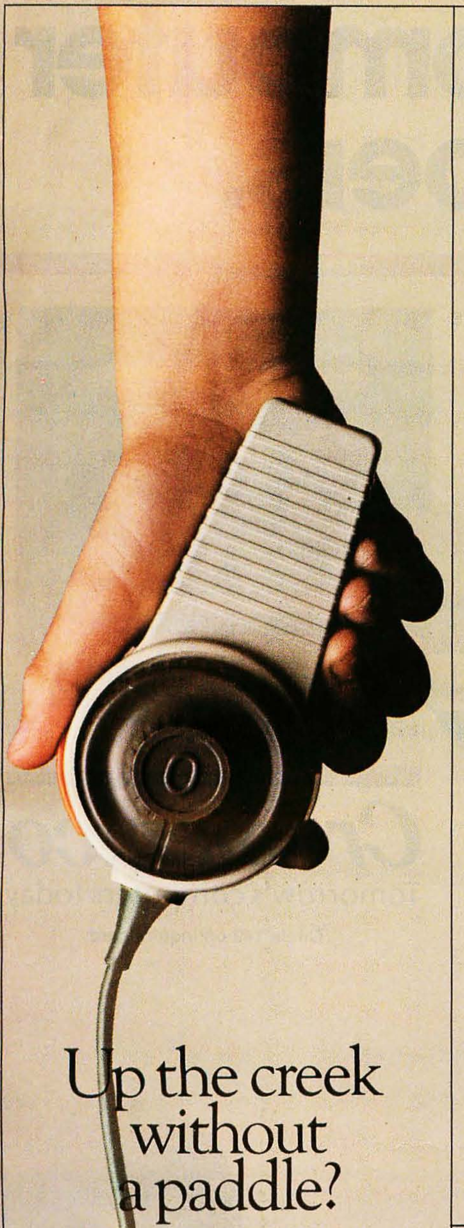
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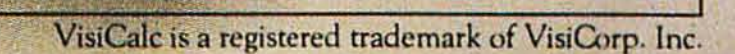
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In The Queue

BYTE Volume 8, Number 5 May 1983

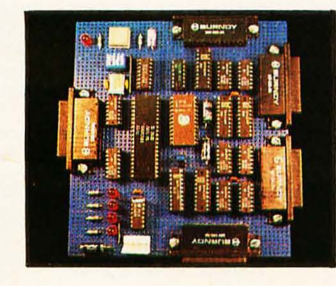
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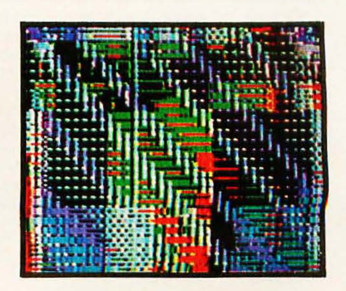
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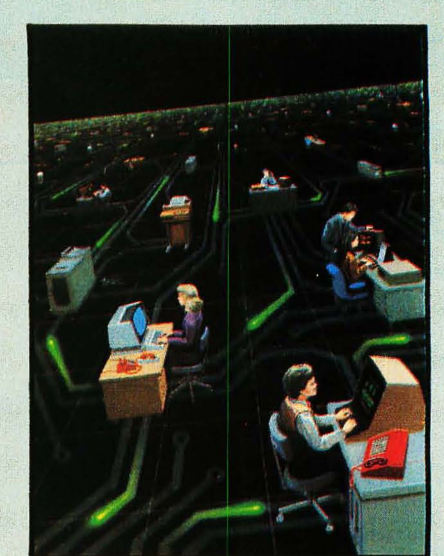
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In This Issue

The complete and integrated electronic office is still a few years away. Yet with each new product that computerizes an individual task or an entire procedure, we move one step closer to the day when paper shuffling is just a memory. Someday, as Robert Tinney suggests in his cover painting, workers at all levels will electronically communicate with the aid of the mighty microprocessor. In "Local Area Networks" Harry Saal discusses the need for standardizing communication protocols for physically separated equipment, such as personal computers, mainframes, printers, and disk drives. Steven Barry describes "The Fortune 32:16 Business Computer," a multiuser, multitasking system that runs enhanced Unix. In "The Movable Conference" Irving A. Lerch reports on computer-moderated conferencing, and in a companion piece, "Electronic Publishing: The New Newsletter," Arthur S. Bechhoefer talks about how a traditional newsletter became a computer-accessed interactive investment advisory service. We have reviews of Radio Shack's new Model 100 portable computer and of two versions of a new computer from Osborne, the Executive and the Executive II. In "Stalking the East-Asian Microcomputer," Phil Lemmons chronicles his five-nation tour of the Far East. Steve Ciarcia's project is to "Build an RS-232C Code-Activated Switch." Plus our regular features and more reviews.

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Editorial

Disenchantment with Detroit

Lawrence J. Curran, Editor in Chief

Signs abound that a long recession—the first to seriously affect computer manufacturers—is just about over. Anticipating upturns in demand, steel and auto makers have been recalling some employees laid off months ago. Declining oil prices cheer economists even as OPEC members gnash their teeth. Consumer prices have stabilized generally, and some economic forecasters don't expect them to rise again until the second half of the year. Amid these upbeat indicators, however, there is clear evidence that the U.S. economy may never again be able to rely on such former bellwether industries as steel and autos. Millions of American consumers are disenchanted with Detroit because they believe U.S. auto makers no longer produce the type of product they want.

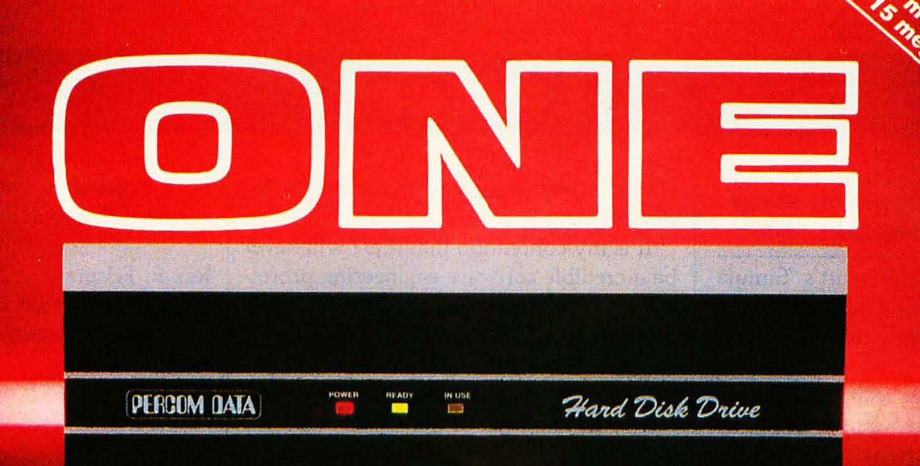
A recent editorial in the *Wall Street Journal* cited studies that quantify the disenchantment. In that editorial, John Schnapp, vice-president of Harbridge House, a Boston consulting firm, reported that of the buyers of U.S. subcompact cars surveyed recently only 22 percent were completely satisfied with their autos; 41 percent of the buyers of comparable import vehicles expressed complete satisfaction. Schnapp said further that U.S. auto buyers believe that Detroit has failed to deliver on three of their foremost needs—acceptable purchase prices, fuel consumption, and maintenance costs. The editorial concludes, among other things, that "the unlikelihood of a reconciliation between Detroit and the consumer will, unfortunately, dampen the prospects for a strong and broad-based recovery" from the recession.

We agree with Schnapp, but what does all this have to do with computers? We think that the U.S. computer industry can supplant the auto industry as an economic bulwark, especially if the management of computer companies heeds the lessons of Detroit. Simply stated, Detroit fell out of favor with part of the American-car-buying public because Americans no longer believe that U.S. auto manufacturers can satisfy their need for reliable, economical transportation.

As this nation shifts from a smokestack-based economy to a high-technology-based economy, computer manufacturers will face a similar consumer challenge. Both domestic and foreign suppliers have the opportunity now to discern what buyers need and follow through on delivery. Those suppliers who don't consider consumer wants and needs in terms of economy and reliability will see that opportunity slip away.■

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Spreadsheet Programs Help to Simulate Digital Logic

I enjoyed Robert McDermott's "Simulation of Simple Digital Logic through a Computer-Aided Design System" (January 1983 BYTE, page 396). However, exactly the same results can be achieved with considerably less effort using the built-in Boolean functions of one of the popular electronic spreadsheet programs. I have not seen this application of these versatile programs described elsewhere in print.

As in McDermott's article, complex digital structures such as D or JK flip-flops can be built up out of gates, simulated by Boolean expressions. Once a library of these structures is built up, the spreadsheet program can store them, and they can be moved about and replicated to form more elaborate structures. Used this way, spreadsheet programs have the same limitations as McDermott's program: modest size and no way to handle hardware considerations such as gate propagation delay. In addition, care must be taken with feedback loops. However, for the casual user, simulating digital logic with one of these popular programs is far easier than adapting and validating McDermott's program.

Stephen R. Troy
717 Cottonwood Dr.
Severna Park, MD 21146

Better Software Through Engineering

Allow me to congratulate Daniel Ross on his excellent (succinct) letter (February 1983 BYTE, page 26). I agree with him completely when he contests Jerry Pournelle's defense of software hacking.

Having spent many years hacking away at my own codes and those of my fellow hackers and watching in embarrassment the inevitable and untimely crashes of those programs, I learned painfully that hacking creates programs that are at best unreadable and at worst unreliable. The (mal)practice is so prevalent and its results so uniformly bad that software maintenance costs are astronomical, and most people have come to assume that all programs have bugs. In fact, widespread hacking undermines the technical and ethical advancement of the software industry.

It is my contention that there will never be a credible software-engineering profession until we can guarantee the performance of our programs the same way a structural engineer guarantees that his bridge will stand. A hallmark of a professional is his legal responsibility for his product. Just as we can sue the physician for malpractice, we can sue the professional engineer if his bridge falls down. Has anyone ever tried to sue a programmer whose program did not work?

It has been my repeated experience that the only programmers who can guarantee that their codes will work are those who are skilled and disciplined enough to engineer their software. Using rigorous and systematic techniques to complement their creativity, these programmers work hard to produce a professional-quality program, a correct program, a program that can be reviewed by other professionals as well as coded in a reliable and maintainable fashion. When the profession climbs out of the mud, these people are the ones who will be able to take full, legal responsibility for the work they do. The hackers will have to find another way to make a living.

Robert B. Dial
Comsis Corporation
Wheaton, MD 20902

Benchmark Surprise

In the November 1982 BYTELINES column (see "Latest 32-Bit Microprocessor News," page 542), it was reported that someone at Berkeley had run benchmarks on several 16- and/or 32-bit microprocessors and then rated them, with a DEC VAX (what model?) being a 1.00.

Surely Intel Corporation's iAPX-432 can do better than 0.05, when the 8-MHz Motorola 68000 got a 0.6, even if the 432 *was* running at half the speed of the 68000. Even the 8086 at 5 MHz got into the tenths.

Thanks for the great magazine; I'll keep my subscription going forever at this rate. Tell Steve Ciarcia not to forget his MPX-16 after these first three articles; we'll be wanting more. How about a special graphics terminal, based on one of the new high-resolution chips, that could be plugged into the MPX-16's (or IBM Personal Computer's) peripheral slots?

Rex E. Felsman
PSC #2 Box 13508
APO San Francisco, CA 96367

The Sieve Revisited

We read with great interest the January 1983 BYTE article by Jim Gilbreath and Gary Gilbreath, "Eratosthenes Revisited: Once More Through the Sieve" (page 283). Of particular interest to us was the inclusion of an APL solution. We recognized that this APL was of a nonstandard syntax. Typically (per the APL of STSC, I. P. Sharp and Associates, and the ANSI APL Standards Committee), within a statement, interpretation occurs from right to left; but when there are multiple statements per line (statements are separated by the '◇' symbol), these statements are considered for interpretation from left to right. The published APL solution required right-to-left line execution.

We transposed the published APL as follows:

```
     ∇ THEIR∆PRIME N
[1]    B←I←1 ⋄ PTR←Nρ0
[2]   L1:PR←(~PTR)/⍳N
[3]    →(N<B×B←PR[I←I+1])/END
[4]   ST:PTR←PTR∨(Bρ0),B↓Nρ,B↓Nρ1⌽B↑1
[5]    →L1
[6]   END:PR
     ∇
```

We were then able to give it a try on The Upjohn Company's IBM 3081 running I. P. Sharp and Associates' Spring 1982 release of APL under the IBM MVS operating system. A couple of full runs yielded processor times of around 256 milliseconds for an N of the first 8191 integers. After looking at the resulting list of primes we noticed a few nonprimes; obviously 8190 is not prime, nor are the more subtle 8133 (79 × 103), 8159 (41 × 199), and 8189 (19 × 431).

The above results put us into a debug mode, but as is often the case, debugging turns into a rewrite. We would thus like to submit an alternate APL solution that we believe rivals (beats) the best of the compiled or interpretive languages for speed of execution and memory requirement:

```
    ∇ OUR∆PRIME N
[1]    P←NρB←1 ⋄ NS←⌊0.5+N*0.5
[2]   L1:→(NS<B←B+(B↓P)⍳1)↑L2
[3]    P←P∧(Bρ1),B↓Nρ~(−B)↑1 ⋄ →L1
[4]   L2:ρP←P/⍳N
    ∇
```

When we set our function loose on the first 8191 integers it required around 57 milliseconds to find all primes (approximating the time required for the first 10 iterations would thus be 57 × 10 ÷ 57 = 22 milliseconds). Artificially stopping our solution at 10 iterations (rather than letting it stop at the square root of N, the largest integer) produced processor times around 30 milliseconds.

Our solution reduces the execution time by:

1. working primarily with a bit string, N bits long, rather than the entire list of N integers. This reduces both the execution time and the memory requirement (note: we were able to search the list of primes up to 792353 in only 300,000 bytes of work space, including space taken up by the program).
2. working with more efficient and fewer bit-string generators and primitives, and
3. taking the square root of the ending integer (used to test end of iteration) only once before the loop rather than taking the square of each newly found integer.

We hope that we have saved the name of APL by showing that although it is an interpretive language (and our processor time represents both interpretation and execution time), it can produce a fast, memory-efficient, and succinct solution. One additional benefit is the flexibility of this solution—without modification (or recompiling, linking, or loading) it may be used to locate primes in variable lists of integers from 1 to N where N ≤ 792353.

Michael C. Rowe, Ph.D.
Donald F. Stoneburner, Ph.D.
The Upjohn Company
7000 Portage Rd.
Kalamazoo, MI 49001

You might like to add the following data to your prime-number benchmark *database* (see the September 1981 BYTE, page 180, and the January 1983 BYTE, page 283). I ran the Sieve of Eratosthenes program on the *Apple II* in Micromotion FORTH (200 seconds) and Manx C tailored for Apple DOS (400 seconds). On a Data General MV/8000, using FORTRAN 77, I got a benchmark time of 2.2 seconds.

The Manx version of C that I used employs a p-code interpreter.

John Figueras
65 Steele Rd.
Victor, NY 14564

BCD Conversion Better by a Bit

I am a programmer specializing (for the moment) in Apples and working mostly in assembly language, and I find the machine-code program examples in your magazine a fascinating source of entertainment. I always look forward to the chance to analyze them. However, I found a few irregularities in listing 1 of Pat Coghlan and George White's "Another Binary to BCD Conversion Routine" (January 1983 BYTE, page 387). Unless the user has some code located at hexadecimal 1003, line 1440 (JMP $1003) should be changed.

The use of indirect indexed addressing would have eliminated the need for the use of location hexadecimal 56 in lines 1740 and 1750. Line 1750 could have been replaced with ADC (BCD),Y and line 1740 could have been eliminated. This would also save two clock cycles per iteration. Also, the comments in lines 2040 and 2050 state that the incoming carry will be added to the entire BCD (binary-coded decimal) field.

The incoming carry is the most significant bit from the last state of the binary field. However, the PBCD routine (lines 2070 through 2140) deals with only the least significant byte of the BCD field. Furthermore, on the first call to this subroutine, the BCD field is cleared to zeros, and for all other calls the BCD field has just been added to itself. This means that the BCD field will be either zero or an even number, and in either case the least significant bit will be zero.

Because the maximum value added to the BCD field by this routine is one and the least significant bit is always zero, no carry is ever possible. The BCC (branch on carry clear) following the add will always be taken. This causes the BPL (branch on sign flag equals zero) in line 2130 to be always bypassed. I have implemented this routine with the indirect indexed addressing in line 1750 and with lines 2120 and 2130 deleted, and the routine still seems to work accurately.

Carl Haddick
Rte. 1, Box 215
Mexia, Texas 76667

Apples and Fords

In the letters column of the February 1983 BYTE (see page 24), Fred K. Fox draws an analogy between the Model T Ford and the microprocessors of today. I found an automotive approach relevant to the Apple IIe and Lisa computers reviewed in that issue.

Apple's Jobs and Wozniak (like Henry Ford) detected a huge, untapped market and produced a general-purpose machine. With little competition, it swept the field. As the public got used to the new machine, however, people began to develop more focused ideas about what they wanted from it. Other makers brought out models designed to deliver specific packages of features to specific market segments, at prices tailored to the market.

But Ford and Apple misread the resulting erosion of their markets as a need to incorporate the specific features of their competitors into their "universal" machines. Hence Ford tinkered with the Tin Lizzie, and Apple came up with the Apple II Plus and now the Apple IIe. But still, when most people look at the market, there always seems to be a specialized machine that delivers features a little better suited to their specific needs, and/or at a little better price. The machine that sets out to be a jack-of-all-trades winds up being the master of none.

Lisa, on the other hand, seems analogous to the DeLorean. Both were designed as "machines of the future," embodying all sorts of bells and whistles that technophiles had been daydreaming about for some time. Most people agree that they're mighty fine machines, with features that it would sure be nice to have. Then they look at the price. After picking their jaws up off the showroom floor, they decide that they can somehow live another few years without those features, and go buy some other model.

Erwin S. Strauss
9850 Fairfax Square #232
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Circle 306 on inquiry card.

Little Big Computer
The TRS-80 Model 100 Portable Computer

Rich Malloy, Technical Editor

Way back in 1977, Radio Shack introduced the TRS-80 Microcomputer System, a computer we now know as the Model I. It was not the first microcomputer to become available, but it was one of the first *complete* computer systems to be offered to the general public. The Model I subsequently spawned a whole line of microcomputers. The familiar gray-and-black motif became a standard feature of small businesses all over the country, and Radio Shack became one of the country's leading computer manufacturers. Now, six years after the Model I, Radio Shack releases the TRS-80 Model 100 (see photo 1), which by its small size, its off-white color, and its easy-to-use features seems to signal a new direction for the Texas company, a direction that may prove to be as significant as that of the original Model I.

In brief, the Model 100 is a big computer in a little package. It features a large (8-line by 40-character) LCD (liquid-crystal display), a standard-size keyboard, a low-power version of the 8085 microprocessor, 32K bytes of ROM (read-only memory), 8 to 32K bytes of RAM (random-access read/write memory), and a cassette interface. It also includes a built-in direct-connect modem with auto-dial and auto-log-on capabilities, an RS-232C serial port, a parallel printer port, a real-time clock/calendar, and even an interface for a bar-code reader. And that's just the hardware. The built-in software includes an easy-to-use text editor, a Microsoft BASIC interpreter, a communications program for the modem, and an address-book and appointment-schedule program. This all comes in a box that weighs less than 4 pounds and is smaller than the manual for the Model I. The price ranges from $799 to $1134, depending on the amount of memory you need. Overall, this is a well-designed, integrated machine that should prove to be very useful to a large number of people.

The Model 100 is not perfect for everyone, however. Serious hardware hackers will be frustrated by the inability to swap boards. Software enthusiasts will want more RAM and some disk storage. And professional writers will need a larger display and a lot more memory. Taken in its own context, however, the Model 100 is an extremely successful design. It should be quite useful for three groups: businesspeople who need a portable workstation, advanced computer users who need a portable terminal for their main system, and



Photo 1: *The TRS-80 Model 100 Portable Computer.*

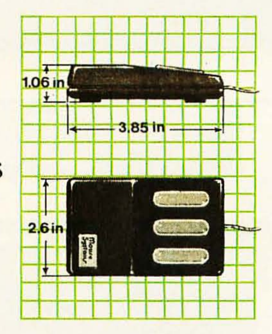
Test drive our mouse.

It's no secret. This is certainly "The Year of the Mouse."

And the uproar is justified.

This "see and point" interface is the most natural, powerful and efficient way to interact with your computer.

And Mouse Systems' optical PC Mouse, now available with software support for the IBM PC, is easily the best of its breed; easily the best at making your computer user-friendly.



Slim, compact size allows brisk moves in any direction.

Grasp The Future of PC Technology

Slide our PC Mouse across its deskpad. It's optical. There are no moving parts. Your cursor instantly moves across your CRT in response.

No other device gives you such total, accurate control over cursor positioning.

The ergonomically designed PC Mouse is so smooth and natural in its movements, you'll soon be using it almost subconciously.

Your attention can thus remain on the screen and not on the keyboard, and your concentration will be increased dramatically.

PC Mouse lets you use this new freedom to take full advantage of today's "visual" software products.

(For a truly enlightening experience, ask your dealer to demo PC Mouse with IBM's Personal Editor.)

PC Mouse vs. The Keyboard

Named Mini/Micro's most significant new product of 1982, PC Mouse lets you bypass your keyboard for instant menu selection and function activation.

And PC Mouse requires no changes in your existing software. All cursor-related functions in Wordstar, VisiCalc, and other popular programs are replaced by the mouse.

In one darting stroke, you eliminate the pondering and second-guessing of typing complicated command codes.

For systems designers and OEM's PC Mouse's potential is staggering.

Simplicity, Itself

Just attach the PC Mouse to your PC's RS-232 port.

Each of the three buttons is user-programmable, giving you nine different functions at your fingertips.

And our software compatability assures instant system integration and simple start up.

PC Mouse keeps your attention on your data, not on your keyboard.

Get It Now

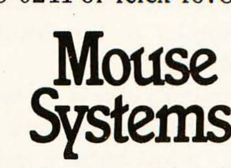
PC Mouse is immediately available for $332.00 including control software and all necessary hardware for your IBM PC.

For ambitious software developers, the optional $40.00 MouseWindow™ software package includes routines to do high resolution graphics and "pop-up" windows.



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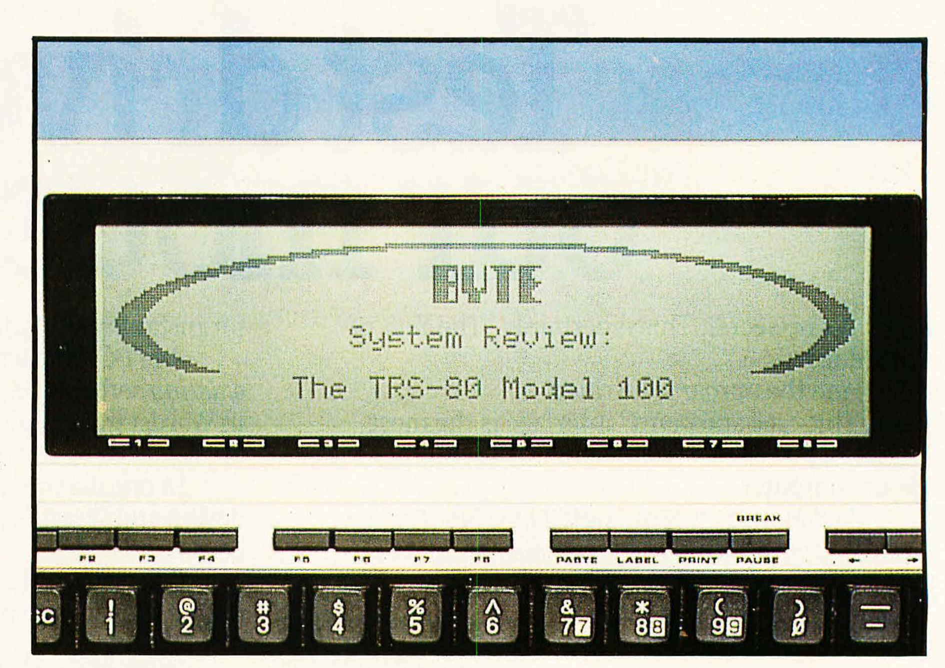


Photo 2: *A close-up of the liquid-crystal display of the Model 100. The display size is 8 lines by 40 characters (64 by 240 pixels).*

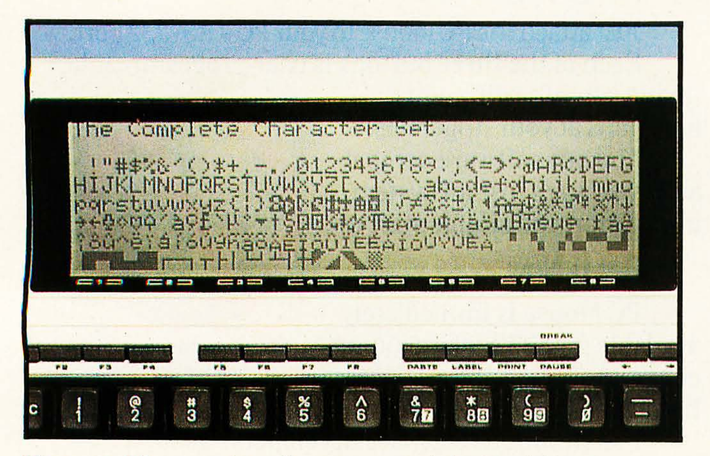


Photo 3: *The complete character set of the Model 100.*



Photo 4: *The Model 100's keyboard.*

novices who want to experiment with a useful, powerful computer for a fairly modest cost.

Physical Dimensions

Because desk space tends to get crowded and briefcases rapidly fill, the size of a portable computer is a key factor. As for the Model 100, if you can make space for a standard 3-ring binder, you have more than enough room for this machine. The dimensions are 11⅝ by 8¼ by 2 inches, similar to the Epson HX-20. The weight is 3 pounds, 14 ounces.

The computer's case is off-white, a color that is becoming popular with Radio Shack. The top of the unit shows the display, a low-battery indicator, and the keyboard. On the right side are an on/off switch, a dial for adjusting the LCD's brightness, and an AC adapter connector. On the left side are the bar-code-reader connector and two switches for the modem (direct/acoustic and originate/answer). The rear panel contains the phone connector, the cassette connector, a printer connector, an RS-232C connector, and a well-protected Reset button. The bottom of the unit features the battery compartment, a compartment for an expansion ROM module and an external bus connector, and a RAM power switch (to be turned off only when the machine will not be used for an extended period).

The Display

The first thing you notice about the Model 100, besides its size, is the LCD shown in photo 2. The Model 100 can display 8 lines of 40 characters each. That's a little less than half of the typical home computer screen. It also can display graphics with a resolution of 240 by 64 pixels. Each character is composed of a 5- by 7-pixel area. Lowercase descenders on letters such as p and q make use of the row of pixels below the character area that is normally used to separate lines. The bottom line of charac-



EXTRA

S-100 World News

MACROTECH International Corporation **22133 Cohasset Street, Canoga Park, California 91303 • 213-887-5737**



Image achieved by DGS' CAT 1600 Series color video graphic workstation. Picture courtesy of Digital Graphic Systems, Inc. See story below.

GRAPHICS: NOW MAX-IMIZED

CANOGA PARK—March 30, 1983—The decreasing costs and increasing density of memory made possible the present boom in digital graphics. Graphic systems designers are now able to take another major step with the introduction of MAX-M, a one megabyte memory board for $1983. As large size system memory and multi-megabyte Virtual Disk, MAX-M opens up major new low cost implementations.



Wayne Maw, Director of R&D for RGB Dynamics, Salt Lake City, Utah, reports, "My application is dependent on speed. With the Macrotech dynamic board, I have the needed speed." The RGB system is a Z80-based, high resolution color directory system for shopping malls, due for April release.

Empirical Research Group of Kent, Washington, creates a state-of-the-art high resolution color video graphics system by integrating their fast 68000 computer, Macrotech system memory, and the color video image processor from Digital Graphic Systems, Inc., Palo Alto, California. Radcliffe Goddard of Digital Graphics states, "High speed image processing requires large system memory to provide instantaneous display frame paging."

The demand for MAX-M by the graphics industry was nearly instantaneous following the initial Macrotech announcement. MI

MAX—256K to 1M S-100 Memory

CANOGA PARK—March 30, 1983—Mike Pelkey, Macrotech International president, today released details of the revolutionary MAX line of S-100 memory boards. Pelkey stated: "IEEE-696 now has a new standard for dynamic memory. The MAX product line offers 256K to 1M, at a price that ranges down to less than $0.00023 per bit." Pelkey continued, "The MI product line now includes our ultra fast (70 ns) 128K static memory, with battery backup capability, plus the 150 ns dynamic memories—in every 128K step from 256K through 1M (1024K) bytes, and add-on kits to permit field upgrade of sizes."

The extreme density of the MAX family is made possible through the use of proprietary PALs (programmable array logic). Also stated as available for add-on to any size MAX is Macrotech's popular M³ memory mapping architecture. M³ permits the 16-bit address space of an 8-bit processor to be dynamically mapped in 4K pages into as much as 16 megabytes of physical memory.

Parity error detection and 8/16 bit data transfer capabilities are provided as standard on the MAX series memory board. MI

PRICE INDEX

	SIZE	P/N	PRICE
Static Memory	128K	128-ST	$1232
Dynamic Memory 24-bit Addressing	256K	MAX-256	$1108
	384K	MAX-384	1292
	512K	MAX-512	1647
	768K	MAX-768	1815
	896K	MAX-896	1899
	1M	MAX-M	1983
With 16-bit M³ Addressing option, add $91			
	FROM/TO	**P/N**	**PRICE**
Upgrade Kits	256K/384K	MKT-2/3	$ 192
	256K/512K	MKT-2/5	692
	256K/768K	MKT-2/7	876
	256K/896K	MKT-2/8	967
	256K/1M	MKT-2/M	1060
	384K/512K	MKT-3/5	600
	384K/768K	MKT-3/7	784
	384K/896K	MKT-3/8	876
	384K/1M	MKT-3/M	968
	512K/768K	MKT-5/7	284
	512K/896K	MKT-5/8	376
	512K/1M	MKT-5/M	468
	768K/896K	MKT-7/8	192
	768K/1M	MKT-7/M	284
	896K/1M	MKT-8/M	192
M³ option		MKT-M3	121
Software (provided on 8" disk) Virtual Disk for MP/M II* and CP/M 2.2, CP/M 3.0* Bios modules, CP/M memory tests			$ 25
Manuals (sold separately) 128/ST			$ 15
MAX Technical Manual			15

Software for M³ Available



BURBANK—March 30, 1983—"M³ bank switching for 8-bit processors is much more useful with the new creative systems programs," states Dan West of Westcom Systems Inc. MP/M II* disk intensive applications are greatly improved with the new Virtual Disk routines now available through Macrotech OEM's and dealers for their M³ memory boards.

Westcom Systems, as the software consulting firm for Macrotech, has also provided subroutine listings to easily incorporate M³ mapping into the new CP/M 3.0* (CP/M Plus*) Bios module. The advantages of CP/M 3.0* with disk buffering, hashed directories, and user program expansion go hand in hand with Macrotech's flexible "bank switched" memory capabilities.

All Macrotech software and manuals are available through Dan West's Compuserve account #70250,102. Leave comments/questions as E-Mail.

These new techniques can combine the above features with custom needs of the future, such as printer buffering, multi-page display and memory-intensive graphics displays.

The software listings are included in the Macrotech memory board manuals and are optionally available on 8" diskettes. MI

*CP/M 3.0, CP/M Plus, and MP/M II are registered trademarks of Digital Research Inc.

Circle 271 on inquiry card.

At a Glance

Name
TRS-80 Model 100 Portable Computer

Manufacturer
Radio Shack
One Tandy Center
Forth Worth, TX 76102

Uses
Portable word processing, programming, and telecommunications

Dimensions
11⅝ by 8¼ by 2 inches
(3 pounds, 14 ounces)

Features
8-line by 40-character liquid-crystal display, full-size, full-travel keyboard, 8085 microprocessor, 32K bytes of ROM, 8K to 32K bytes of RAM, cassette interface, built-in direct-connect modem, RS-232C interface, parallel printer interface, real-time clock/calendar, bar-code-reader interface, and piezoelectric tone generator

Software
Text editor, BASIC interpreter, communications program, address-book program, and appointment-calendar program

Documentation
Reference manual: 200 pages, spiral-bound
Pocket manual: 40 pages

Price
8K bytes RAM: $799
24K bytes RAM: $999
32K bytes RAM: $1134

Options
Phone connector ($19.95), printer cable ($14.95), cassette cable ($5.95), and acoustic adapter for modem (approximately $50, to be available 3rd quarter 1983)

ters can be used either as part of the display or as a line of labels for eight function keys.

The full 96-character ASCII (American National Standard Code for Information Interchange) set can be displayed along with 128 extra foreign and graphics symbols (see photo 3). Some of these graphics symbols are nonstandard and cannot be printed on Radio Shack printers. Reverse video characters are available, but apparently not through BASIC.

The screen contrast is fairly good, but decreases quickly as you move away from an optimum viewing angle of about 60 degrees from the horizontal. Contrast can be adjusted with a dial on the right side of the machine. I had no problem reading the display whether it was on a desk or on my lap. The LCD does tend to reflect ceiling lights, however, and this could be a problem in certain offices. Placing the unit on your lap should solve this problem somewhat.

As in most displays, scrolling is done line by line, rather than pixel by pixel (smooth scrolled). The display seems a little slower than most video displays, but not objectionably so. Although the display is smaller than the typical home display—and a great deal smaller than the typical 80 by 24 office display—I grew accustomed to it fairly easily. It is a very good size for menus. The main problem occurs with tabular material wider than 40 columns. But tables tend to be a problem on *all* machines, and fortunately such tables do not occur frequently in general correspondence.

The large size of the characters and the nonflickering quality of the LCD caused me much less eyestrain than the usual cathode-ray tube display.

The Keyboard

The second most obvious thing about the Model 100 is its full-size keyboard (see photo 4). While the display is obviously limited by the small size of the unit, the keyboard exhibits few signs of compromise. In fact, it is one of the nicest keyboards I've used on any machine, large or small.

While the Model 100's display was obviously limited by the small size of the unit, the keyboard exhibits few signs of compromise.

Most of the keys are in the standard Selectric-style arrangement. The Backspace, Control, and Return keys are in their usual places. The cursor control keys are located just above the Backspace key and are arranged in a horizontal row (L-R-U-D). This cursor key arrangement is fairly common, but I much prefer a diamond arrangement for these keys.

The keyboard is controlled by its own microprocessor, and it has a good type-ahead buffer. No matter how fast I typed, no characters were dropped. Key repeat is also provided.

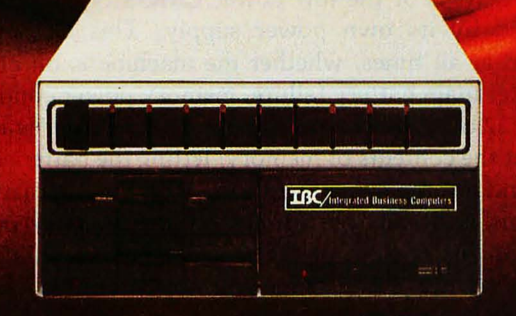
Special shift keys marked Code and Graph allow you to key in all 256 of the Model 100's characters directly from the keyboard.

Twelve function keys are located above the main keyboard. Four of these are permanently marked and have constant functions in all the application programs that come with the machine. "Paste" works as a Block Insert key; "Label" turns the line of function key labels on and off; "Print" is used to print either the contents of the display or an entire file; and "Break/Pause" either terminates or temporarily halts execution of a process, depending on whether the key is cap shifted or not.

The other eight function keys are programmable and are not permanently labeled although they tend to have the same function in each application program. This is a good design feature. As mentioned previously, the bottom line of the display can be used as a label for these keys. Unfortunately, the labels do not line up exactly with the keys. These keys also have interrupt capabilities that could be put to use by advanced computer users.

A "Num" key converts some of the keys into a slanted numeric keypad. Because I'm not a numeric touch-typist, I couldn't test how easy this strange configuration would be to work with. If a numeric keypad is important to you, I suggest you test this keypad in the store to see if you can work with it.

When you're looking for a heavyweight performer at a low price, IBC outweighs the competition.



ALTOS

IBC MIDDI CADET™

Maximum Users	9
Disk Storage	20 MB
Memory	256 KB **
CPU Speed	6 MHz
Benchmark (Elapsed time)	1:44 Minutes*
List Price	$7495.00

ALTOS™ ACS 8000-10

Maximum Users	4
Disk Storage	10 MB
Memory	208 KB
CPU Speed	4 MHz
Benchmark (Elapsed time)	5:03 Minutes*
List Price	$7995.00

The **IBC MIDDI Cadet** is better, faster and less expensive than the ALTOS ACS-8000-10 and others. That's why we call it the heavyweight performer.

Because the **MIDDI** is completely software compatible with ALTOS, ONYX™, Dynabyte™ and others using CP/M™ 2.2, MP/M™ II or OASIS™, you can transport your applications software to the **MIDDI** without modification. So why not take the benchmark test yourself.

If you are an OEM, system integrator, multiple end user, or dealer for any of our competitors, send a copy of your application program to **IBC.** We will run your software on the **MIDDI** without modification and give you the elapsed time in minutes. You be the judge. If it really is faster than your current hardware and it is, then you owe it to yourself and your customers to switch to IBC.

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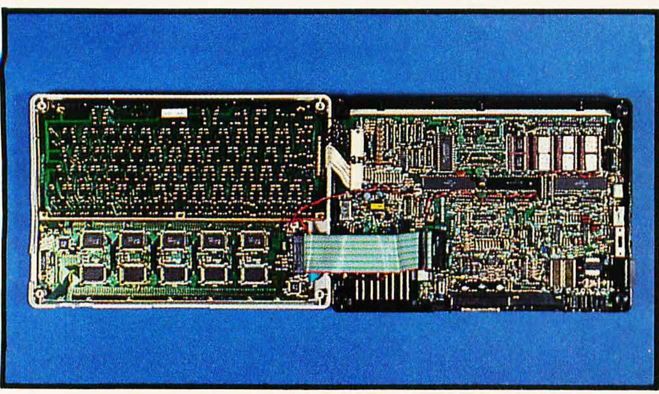


Photo 5: *Inside the Model 100. On the right side are the undersides of the liquid-crystal display (top) and keyboard (bottom). The left side shows the main circuitry. The modem circuitry is in the upper left-hand corner. The random-access memory is in the lower left-hand corner. The 80C85 microprocessor is in the central part of the left side.*

One slight problem with the keyboard is the sound each key makes. It's not a click exactly; it's more like a pop—a quite audible pop. In fact, a plane full of business executives typing on these machines might drown out the engine noise. That, of course, is an exaggeration, but the key-popping may cause a slight problem in quiet places such as libraries. Admittedly this is a small complaint, but if I were Radio Shack I would investigate putting some type of sound-dampener under the keys.

Processor

The Model 100 uses the 80C85 microprocessor chip, a low-power CMOS (complementary metal-oxide semiconductor) version of the 8085, which is a well-respected member of the 8080 family. The clock speed for the microprocessor is 2.4 MHz. One of the advantages of the 8085 is its extensive interrupt capabilities, which, as we will see later, are well exploited by the Model 100's BASIC interpreter.

Memory

Each Model 100 contains 32K bytes of ROM. This is used to store a small menu-based operating system and five application programs. As for RAM, you have a choice of 8, 16, 24, or 32K bytes. The 8K-byte RAM machine sells for $799. Each additional 8K bytes of RAM costs $120 plus a $15 installation charge. Thus, a 24K-byte machine should cost $799 plus $240 plus $15, or $1054. Radio Shack, however, is offering a special price for the 24K-byte machine of $999—a savings of $55. A full 32K-byte machine should then cost $135 more, or $1134.

The RAM is of the low-power CMOS type, and it is protected by its own power supply. This memory is powered at all times, whether the machine is on or off. Even after main battery failure, memory power continues for 8 to 32 days. There are apparently only three ways to wipe out the contents of memory: letting the batteries run down and not replacing them for a long time, initiating a cold start or Reset, or turning off the memory power switch on the bottom of the machine (which should be done only when the machine will not be used for an extended period of time).

As on most 8-bit processor machines, the maximum addressable memory space is 64K bytes. The memory appears to be allocated as follows: the bottom 32K bytes of memory (addresses 0 through 31999) are taken up by the ROM. The first 8K bytes of RAM fills the top 8K bytes of memory. Each additional 8K bytes of RAM is installed in the next highest 8K bytes of memory. The topmost part of the first 8K bytes of RAM is used by the computer's operating system for display memory and to store pointers for the BASIC programs and document files. These files are stored in the lowest part of RAM. The part of RAM between the pointers at the top and the files at the bottom can then be used for new files or for arrays for the BASIC programs. With a 32K-byte RAM machine, you have 29.6K bytes of RAM free; with the 8K-byte RAM machine, you have only 5.1K bytes of RAM free.

Future ROM modules for the ROM expansion socket will occupy the same address space as the built-in 32K-byte ROM. You will then be able to switch between the two banks of ROM available.

Some advanced users may feel limited with only 32K bytes of RAM. But programs such as the text editor reside outside of the precious RAM area. Also, the display eats up very little RAM. The result is that you can use almost the entire RAM area for document storage.

The machine I used had 32K bytes of RAM, and after about 25 hours of typing notes and running BASIC programs, I still had about 16K bytes of RAM left. Even with the 24K-byte machine, I think I would probably run out of batteries or things to write about before I ran out of memory.

I enjoyed using this type of protected RAM. It was a pleasure knowing that I did not immediately have to save everything and that whatever I put into memory would stay there until I deleted it. Still, on this or any other machine, irreplaceable files should be backed up.

Power Supply

For a portable computer that depends on RAM for data storage, the power supply is a crucial issue. On the Model 100, power is supplied by four AA batteries or by the optional AC adapter. Operating life of the batteries is about 20 hours. This time can be shortened if excessive use is made of the various interfaces (modem, cassette, printer, RS-232C). Because these interfaces will probably be used primarily within reach of an AC socket, this power drain should not be a big problem. The low-battery indicator lights when 20 minutes of battery power are left. I used the machine for about 15 hours, making extensive use of the printer and cassette interfaces, before the low-battery indicator went on. And then the machine continued for another hour and a half before it finally died. That seems to be ample warning to get more batteries.

The Model 100's volatile memory is protected by its own power supply, a separate nicad (nickel-cadmium) battery that is continually recharged by the main batteries or by the AC adapter. When the main batteries fail, the nicad battery will continue to power the memory for an extended period of time, depending on the amount of RAM you have. With 8K bytes of RAM, you have 32 days before the memory is lost. Even with 32K bytes, you still have 8 days to get new batteries.

Modem

In keeping with its portable nature, the Model 100 was given extensive communications capability. A key element in this design is its built-in direct-connect modem. All you need is the optional phone connector ($19.95) and you can plug into any standard modular phone jack. If a modular phone jack is not available, you can use an optional acoustic adapter with any regular phone.

The modem is a standard Bell 103-compatible version with a transmission rate of 300 bps (bits per second). *Auto-dialing* capability is also included. However, it can dial only in the *pulse* mode, like a standard rotary-dial telephone. Radio Shack says it would have liked to add *tone-dialing* capability, but it was not available on low-power CMOS chips. If you have a private telephone system that can handle only tone-dialing, you will have to dial manually. The pulse dialing rate, by the way, can be set at either 10 or 20 pulses per second.

You have the option of using several serial communications parameters: the word length can be either 6, 7, or 8 bits. Parity can be handled in one of four ways: Ignore, Even, Odd, or No parity. The number of stop bits can be either 1 or 2. And the pause/continue protocol frequently indicated as XON/XOFF or <Ctl S>/<Ctl Q> can be enabled or disabled.

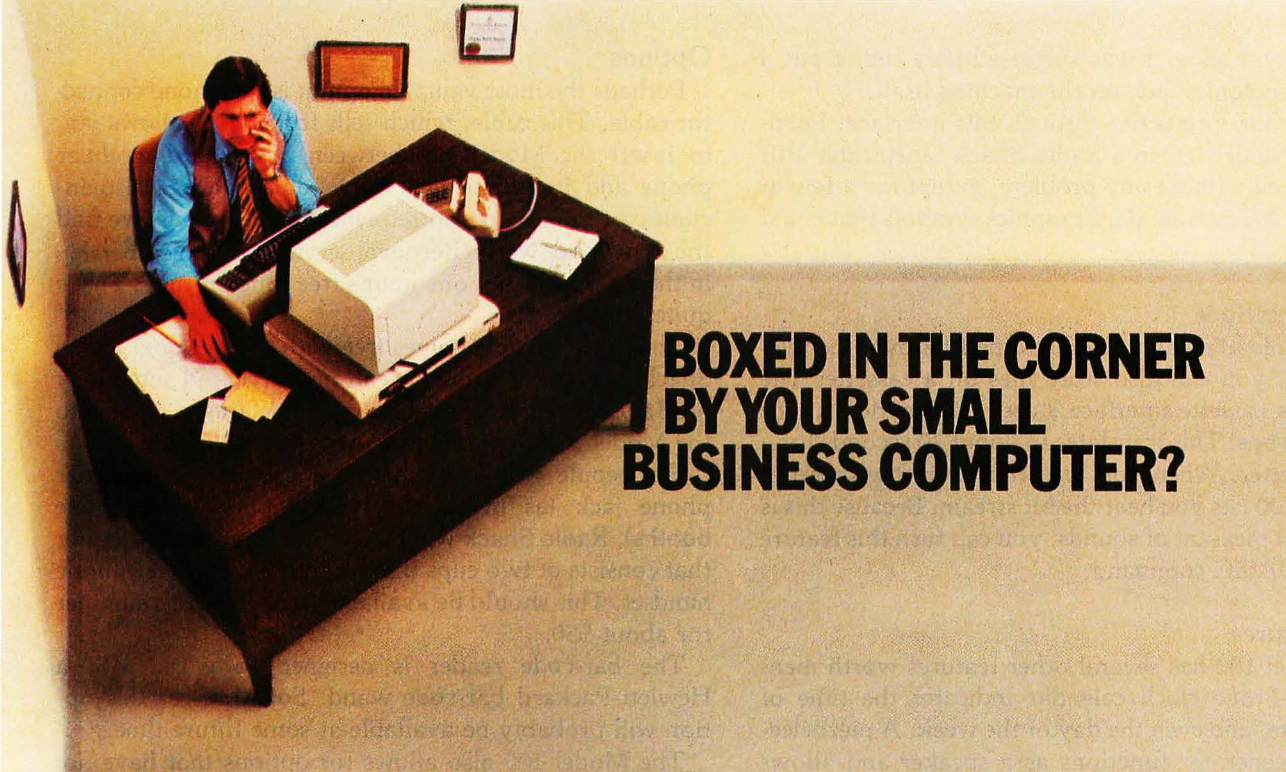
The Model 100's modem in combination with its ROM-based communications program presents a quite powerful package. The only thing I might want to have added is auto-answer capability, but this might not be a cost-effective option. After all, a portable machine like this will probably not be in one place long enough to receive phone calls.

RS-232C Interface

The Model 100 also has an RS-232C serial connector for connecting to serial printers, other computers, or high-speed (1200-bps) modems. This interface uses the same circuitry as the modem, and all communications parameters for the modem will likewise affect the RS-232C connector. Unlike the modem, however, the RS-232C port has a wide range of transmission rates: from 75 to 19,200 bps.

Parallel Printer Interface

For connections to most printers, the Model 100 has a parallel printer port. This takes the form of a 26-pin, dual-row connector on the rear panel of the machine. An optional connector cable converts this to a standard



BOXED IN THE CORNER BY YOUR SMALL BUSINESS COMPUTER?

The trouble with many of today's better known small business computers is they box you into a *single user system.* So after your big initial investment, you still have a single user system. You always will.

Now there's the Zeμs 4 from OSM Computers. *The Zeμs 4 is the first multi-user, multi-processor micro at single user prices.* The Zeμs 4 is less than one cubic foot and weighs 24.6 pounds.

Yet, it's like four separate, powerful small business computers in one. It allows up to four users to share a common data base *or* work independently. Each has his own CPU, 64K of RAM and I/O ports. That means greater operator independence, more processor power and greater reliability.

You needn't worry about running out of storage capacity either. The Zeμs 4 comes with a built-in hard disk, so users share up to 19MB of storage, about twice as much as most other multi-user systems.

You'll enjoy maximum flexibility in software applications too, because Zeμs 4's MUSE operating system runs programs compatible with CP/M. Plus MUSE provides extensive file management functions typically found only on mini computers.

Here's another big advantage: The Zeμs 4 is designed for low maintenance, low down-time. Its four modules snap in and out with a few minutes work. So if repairs are ever needed, modules are simply replaced through OSM's limited warranty program.

Maybe the best thing is that you can buy the powerful and expandable Zeμs 4 for $4,595 ($6,595 fully configured for four users).

The Zeμs 4 from OSM, the latest in a family of powerful, multi-user small business computers. It's the little box that lets you grow without boxing you in.

To find out more, call (800) 538-5120 or (415) 961-8680 in California or write to OSM Computer Corporation, 665 Clyde Avenue, Mountain View, CA 94043.



OSM

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Circle 345 on inquiry card.

Centronics-type plug. I was surprised they didn't put a standard Centronics jack on the machine itself.

The Print key prints out through this interface. I connected the Model 100 to a Radio Shack Lineprinter VIII and it worked without any problem, except for a few of the Model 100's nonstandard graphics symbols that could not be printed.

Cassette Interface

Besides uploading and downloading files over the telephone lines, you can also store files on a cassette. The Model 100's cassette interface stores information at the rate of 1500 bps. This translates to about 20 seconds for a 150-word letter. When you load files from the cassette, the Model 100 lets you hear the bit stream. Because this is not the most pleasant of sounds, you can turn this feature off with a BASIC command.

Other Features

The Model 100 has several other features worth mention. A real-time clock/calendar indicates the time of day, the date, and even the day of the week. A piezoelectric sound generator functions as a speaker and allows you to generate musical notes without using too much power. An automatic power-off feature is also included. After 10 minutes of not being used, the machine turns itself off to save battery power. This time interval can be lengthened or shortened or it can be disabled.

Options

Perhaps the most valuable option is the phone connector cable. This cable, which sells for $19.95, allows you to insert the Model 100 between a standard modular phone and its phone jack. The cable package also includes automatic log-on sequences for Compuserve and the Dow Jones News/Retrieval services, plus membership in these services and one hour's free time on each. That's quite a bit for $20.

The cassette cable comes free with the optional Radio Shack cassette recorder or can be purchased separately for $5.95. The printer cable for connecting a printer to the Model 100's parallel port costs $14.95.

For people who may not have access to a modular phone jack (as in certain hotel rooms or in phone booths), Radio Shack will be offering an acoustic adapter that consists of two cups that fit onto a regular telephone handset. This should be available some time this summer for about $50.

The bar-code reader is designed to work with a Hewlett-Packard bar-code wand. Software for this option will probably be available at some future time.

The Model 100 also allows for options that have not yet been announced. On the bottom of the machine is a compartment for a 32K-byte ROM module. We can only speculate about what type of software Radio Shack will put on such a chip (a mini-spreadsheet program?). Also in this compartment is a 40-pin external bus connector. Radio Shack is not telling, but this would seem to be perfect for adding storage devices or a larger display.

Software

It has frequently been said that you should buy a machine not for its hardware but for its software. Microsoft, the designer of the Model 100's software, really took that maxim to heart. On top of the impressive collection of hardware that makes up the Model 100 is an equally impressive collection of software. This is one computer you can start using immediately; you won't have to wait six months to a year for the software to be developed.

Not only are the various software packages extensive, easy to use, and of fairly good quality, but they also work well with each other and are all crammed into just 32K bytes of ROM. Of course, judging software is a subjective task, but if you keep in mind the design goal of the machine—an easy-to-use portable workstation—I'm sure you'll agree that this goal has been reached and then some.

When the machine is turned on, a simple operating system is engaged and the system's main menu *appears*. This shows the time, the date, the amount of free memory available, and a list of all the files in memory. The five built-in application programs are listed with no filename extension. Document files all have the extension ".DO"; BASIC programs have the extension ".BA".

Choosing a particular file to work with is easy. You simply move the cursor over that file name and press Return. If a document or BASIC program is chosen, the

text editor or BASIC interpreter, respectively, is automatically invoked. Typical operating-system functions such as file deleting are handled in BASIC.

When you finish with a particular file or program, you press one of the function keys marked Menu. This closes your file and returns you to the main menu again. Having the complete list of files appear on each warm boot, as it were, is a particularly good idea. It makes the system extremely easy to use and would save time on any operating system.

The five application programs included as standard equipment are the following: a text editor (TEXT), a BASIC interpreter (BASIC), a communications program (TELCOM), an address-book program (ADDRSS), and an appointment-calendar program (SCHEDL). These programs work well with each other. TEXT can be used to edit BASIC programs or the data files used by TELCOM, ADDRSS, and SCHEDL. Also, TELCOM and ADDRSS share the same data file.

The Text Editor

TEXT will probably be the most used program on the Model 100. It is a full-fledged character-oriented editor (i.e., not a line editor) with word-wrapping, so that words are not broken mercilessly at the end of those 40-character lines. Owing to its compactness, it lacks many of the features found on large packages such as Wordstar or Perfect Writer, but it is well designed, simple to learn, and fairly powerful.

TEXT contains only the most needed functions of a word processor, but makes up for this shortage of functions by making those it has as easy to use as possible. These functions are Insert, Delete, Search (Find), Copy a block, Delete a block (Cut), Insert a block (Paste), Save on cassette, Load from cassette, Print, and Cancel any operation (Break). Note the use of familiar names such as Cut and Paste.

Using TEXT is simple. To create a file, you merely choose TEXT in the main menu. Because it's already in memory, TEXT "loads" in an instant and asks for a filename for your new file. After that everything you enter becomes part of that file. All controls are handled by function keys. You don't have to remember any control key combinations. For those who prefer them, however, each function key has a corresponding control key combination. Of course, if your text will later be used by another word processor, you can embed the necessary commands into your text.

An interesting thing about TEXT is that it is always in the Insert mode. In other words, you can't "write over" anything you've already written. You must insert the new material and delete the old or vice versa. This took a little while to get used to, but it actually makes a lot of sense and saves time. Most of the editing I do is either inserting or deleting, and this makes the first of the two a bit easier.

As I said earlier, some functions had to be left out, but some of these are quite useful. Perhaps they can be handled by small BASIC utilities. For example, a Search and Replace function could probably be handled by a short BASIC routine. Also, an indication of the file length (which is quite important on a machine with a small display) might be provided by a short BASIC word-counter.

Lastly, the Print function allows you to print either the whole document file or just the contents of the display. It will print in whatever line length you want, and the lines will be word-wrapped. The only problem is you can't set the left margin. Again, a short BASIC routine could probably handle this also.

To test the performance of TEXT, I tried a little text-editing benchmark. I timed how long it would take to retrieve a 150-word letter, change the date, the addressee, the address, and the salutation, and then store the new

CLOAD?	Verifies a previous cassette load
CLOADM	Loads a machine-language program from cassette
COM ON/OFF/STOP	Enables/disables communications interrupt
CSAVEM	Saves a machine-language program on cassette
CSRLIN	Returns vertical cursor position
DATE$	Represents the current date (MM/DD/YY)
DAY$	Represents the day of the week (e.g., Fri)
EDIT	Invokes text editor
ERL	Gets line number of error
ERR	Returns error-code number
FIX	Truncates real numbers
HIMEM	Returns high-memory address
INP	Inputs data from a port
INPUT$(N)	Inputs N characters from keyboard
INPUT$(N,F)	Inputs string of length N from file numbered F
INSTR	Searches for a given string
IPL	Defines program to run on power-up
KEY	Defines function key as string
KEY LIST	Lists current functions of function keys
KEY ON/OFF/STOP	Enables/disables function-key interrupts
LCOPY	Copies screen to printer
LINE INPUT	Inputs string from keyboard
LPOS	Returns the current position of printer head
MAXFILES	Represents the maximum number of open files
MAXRAM	Returns the maximum amount of RAM available
MDM ON/OFF/STOP	Enables/disables modem interrupt
MENU	Closes files and returns to main menu
ON COM GOSUB	Defines routine to handle RS-232C interrupt
ON KEY GOSUB	Defines routine to handle function-key interrupt
ON MDM GOSUB	Defines routine to handle modem interrupt
ON TIME$ GOSUB	Defines routine to handle clock interrupt
OPEN	Opens file and sets logical file number
OUT	Outputs a byte to processor port
POS	Returns horizontal screen position
POWER	Sets automatic power-down period
POWER CONT	Disables auto power-down feature
POWER OFF	Turns off machine
PRESET	Turns off pixel in display
PSET	Turns on pixel in display
RESUME	Resumes execution after error
SCREEN	Turns on/off function-key label line
SOUND	Generates a tone
SOUND ON/OFF	Enables/disables beep when carrier signal comes on telephone line
SPACE$	Defines a string of spaces
STRING$	Defines a repetitive string of a given character
TIME$	Represents the time of day (HH:MM:SS)
TIME$ ON/OFF/STOP	Enables/disables time interrupt
VARPTR	Returns memory address of a given variable

Table 1: *Some selected commands found on the Model 100's version of Microsoft BASIC.*

letter. My average time on TEXT was about twice as long as it is when I use Magic Wand, the word processor on my 4-MHz, Z80-based office machine, with which I am quite familiar. Undoubtedly, some of this time difference is due to my inexperience with the portable unit; and some of it is due to the fact that TEXT is always in Insert mode, and thus simple write-over corrections require twice as many keystrokes; but a large portion of the difference is due to the slowness of the Model 100's LCD versus the 9600-bps display on my office machine. Subjectively, however, the Model 100 "seemed" faster than my office machine because it did not need extra time to load the text editor and the document file from the disk and later store the document on disk and reload CP/M (do a warm boot).

This illustrates a nice feature of the Model 100. You don't have to wait for the disk drives or for the display tube to warm up. You can take the machine out of your desk drawer, turn it on, and be writing a memo in about 2 seconds.

Overall, I found TEXT to be a good product. It seems perfectly designed for the Model 100, almost like a hand in a glove. Even the novice user should be able to write a short letter on it in about an hour, and there aren't many word processors you can say that about.

BASIC

For the Model 100's BASIC interpreter, Radio Shack has again gone to its traditional source—Microsoft BASIC. Of course, a few commands are missing on the Model 100 version of MBASIC, but several more have been added to take advantage of the interrupt capabilities of the 8085 processor, and it is well integrated with the Model 100's other application programs.

Table 1 describes some selected commands. Of particular note are the interrupt-handling commands, which can work with the modem, the clock, the RS-232C port, and the function keys. For example, in a long program you can insert a routine to handle an interrupt from one of the function keys. Then, whenever that function key is pressed, control is automatically transferred to that routine. The program does not have to continually check the function keys to see if they have been pressed.

As mentioned before, some commands such as WHILE. . .WEND are missing, but these can be replaced with combinations of other commands.

As for performance, I timed the BASIC interpreter with the Eratosthenes Sieve benchmark described in the January issue of BYTE on page 283. The Model 100 took 2820 seconds for 10 iterations of the routine. Compare this with 2880 seconds for BASIC on the TRS-80 Model III, 2806 seconds for Applesoft BASIC on the Apple II, and 1950 seconds for BASIC on the IBM PC.

Like the other application programs, the BASIC interpreter is integrated with the text editor. The result is that you can edit your BASIC programs in two ways: either by using the common line-oriented approach or by using TEXT. To use the latter method, you merely type TEXT while in BASIC and your program will be translated into ASCII and TEXT will be invoked. When you leave TEXT, your program will be translated back into its normal tokenized form. Long programs can require a few seconds for these translations to occur.

The Model 100's BASIC is also well integrated with the machine itself. Every hardware port and interface seems

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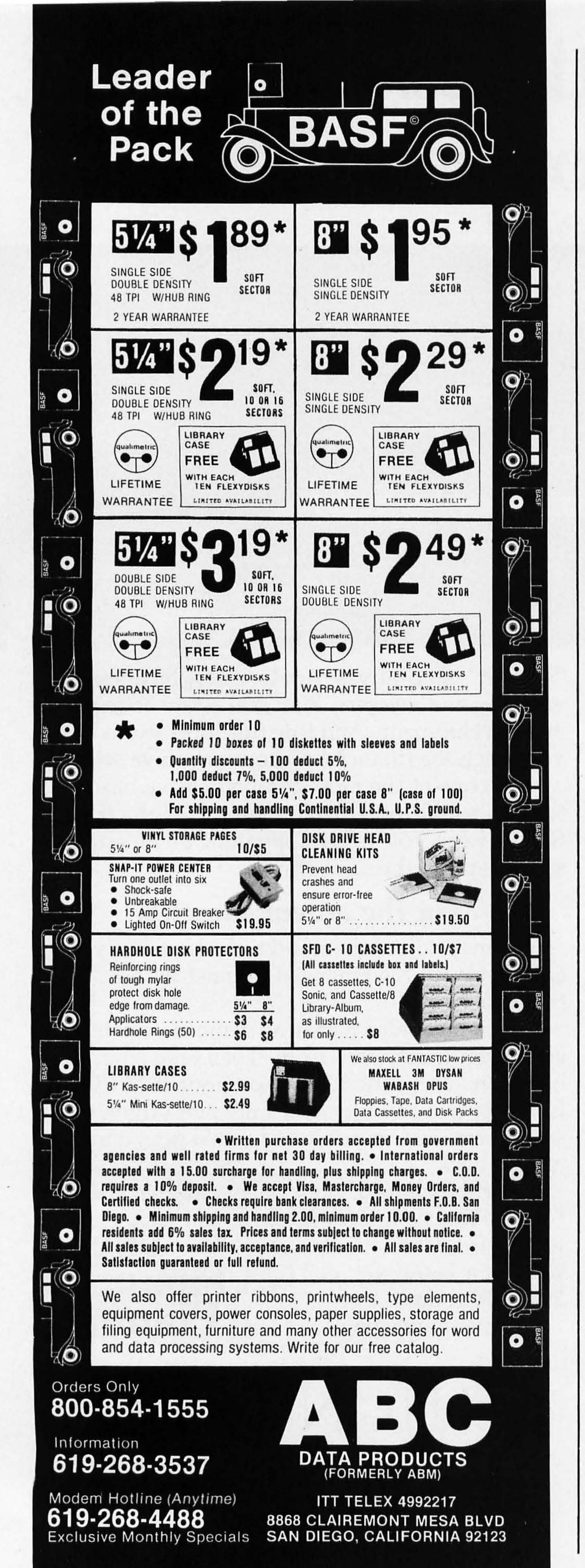
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to be accessible from BASIC. Overall, this version of BASIC is fairly comprehensive and pretty fast for a portable machine.

TELCOM

In order to take advantage of the built-in modem, Radio Shack has provided the Model 100 with a built-in communications program, and a fairly powerful one at that.

With this program, you can automatically dial a database and execute the required log-on procedures. Once online, you simply press a function key to upload any of your document files onto the database or download a file onto your Model 100. Other function keys let you "echo" your communications to a printer or change from the full-duplex mode to half-duplex.

In the event a database sends you more than eight lines of text at once, Radio Shack has even supplied a function key that lets you refer back to the previous eight lines.

The upload routine includes a very important feature that, surprisingly, is frequently missing from communications software packages. When you upload a document, TELCOM will automatically format it to any line length that your database requires. This is important because some systems cannot handle lines that are longer than a certain length.

The TELCOM program can even be used as an auto-dialer for voice communication.

I found TELCOM a bit harder to use than TEXT or BASIC. The auto-dial and auto-log-on routines use special notation, which is a little hard to remember. Of course, auto-log-on procedures tend to be difficult to encode on any system. Fortunately, Radio Shack will help things by including auto-log-on procedures for both Compuserve and Dow Jones with its optional phone connector. Once these procedures are properly encoded on the Model 100, data communications become easy. In fact, some Radio Shack executives have their log-on procedures for Dow Jones set up so that all they have to do is turn the machine on, press a few keys, and a few seconds later the latest price of Tandy stock appears on their display.

ADDRSS and SCHEDL

Two simple programs are provided that can turn the Model 100 into an electronic address book and appointment calendar. ADDRSS can be used to store names, phone numbers, and addresses in a special file called "ADRS.DO", which is also used by TELCOM. Once the data has been stored in this file, you can use a function key marked Find to locate, for example, all records containing the string "Bill" or "Fort Worth." Uppercase/lowercase distinctions are disregarded.

SCHEDL works similarly to ADDRSS except that it uses dates and times rather than names and addresses. It stores this data in a file named "NOTE.DO". Using the Find key, you can quickly locate all records you've entered for a given date or time or all appointments you've made with a certain person.

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Adding a printer to your computer makes sense. But deciding which printer to add can be tricky. Do you settle for a printer with limited functions and an inexpensive price tag or buy a more versatile printer that costs more than your computer? Neither choice makes sense.

Here's a refreshing option—the new, compact STX-80 printer from Star Micronics. It's the under $200 printer that's whisper-quiet, prints 60 cps and is ready to run with most popular personal computers.

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And, of course, the STX-80 comes with Star Micronics' 180 day warranty (90 days on the print element).

The STX-80 thermal printer from Star Micronics. It combines high performance with a very low price. So now, there is nothing in the way of owning a *quality printer.*

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The new STX-80 printer for only $199.*

ADDRSS is pretty handy because it shares its data file with TELCOM. SCHEDL seems somewhat limited by contrast. It would have been nice if Radio Shack had incorporated the clock/calendar into it, but I imagine ROM space must have gotten pretty scarce by the time SCHEDL was added. Again, you could probably write a simple BASIC program to do this. For example, it could check the clock/calendar, then check each record of the NOTE.DO file, and sound some type of alarm when the two coincide. Such a program could automatically tell you when you have an appointment and with whom.

Possible Applications

With all this hardware and software, the Model 100 is well suited for a large number of applications. It should be a great tool for writers, programmers, businesspeople, and students. With the bar-code reader, it could even be used at the local supermarket. The Model 100 looks very flexible. It should be interesting to watch applications for it develop.

Limitations

As good as the Model 100 is, it does have certain limitations.

One is the lack of convenient mass storage. There will be times when you wish you could quickly load and store large documents or programs. Looking at the external bus connector on the bottom of the machine, I wouldn't be surprised if Radio Shack already has a mass-storage device in the works. My guess is either a thin-line 5¼-inch floppy disk or a large disk-simulating CMOS RAM module. Of course, 3½-inch floppies and bubble memory are also possibilities.

Another limitation is the display. Although it is of a useful size, it could be a hindrance, for example, in spreadsheet programs. Again, looking at that bus connector, I've got a feeling some type of video display is on someone's drawing board. Also, as LCDs get larger and larger, I wonder if 16-line by 80-character displays are that far down the road.

A small dot-matrix printer would be a useful accessory for the Model 100. Something on the order of the new briefcase-size typewriter from Brother would be handy.

We're completely in the dark as to what that extra ROM socket might be used for. The best bet is a mini-spreadsheet program. But I wouldn't be surprised if some type of disk operating system were in the works, or even some games. I'm sure Radio Shack will think of something.

Speaking of games, the bit-mapped graphics of the LCD and the interrupt capabilities of the machine might lend themselves nicely to possible game applications.

Documentation

The Model 100 comes with two manuals: a large 200-page spiral-bound manual and a small pocket-size

40-page booklet. The first chapter of the large manual explains how to get the system up and running in as short a time as possible. Later chapters describe each application program in great detail. Several appendixes contain various technical information.

The pocket manual is meant to be the one you take along on trips. It contains much the same information as in the first chapter, plus most of the technical information from the appendixes, in the large manual. I would have liked a reference card with all the application program commands on it, but most of these commands are fairly intuitive anyway. The pocket manual seems like a good compromise between a large, comprehensive manual and a short, incomplete reference card.

The manuals are well written. A novice user should be able to get the text editor working without too much trouble. BASIC and TELCOM may present some problems. Novices might find an introductory book on BASIC helpful. Although the TELCOM section may not be as easy as that for TEXT, it does not seem to be any harder than the databases you will be connecting to.

In addition to the ROM-based application programs, Radio Shack also includes some useful BASIC programs in its manual. For example, one of these will alphabetically sort all the records in your ADRS.DO file.

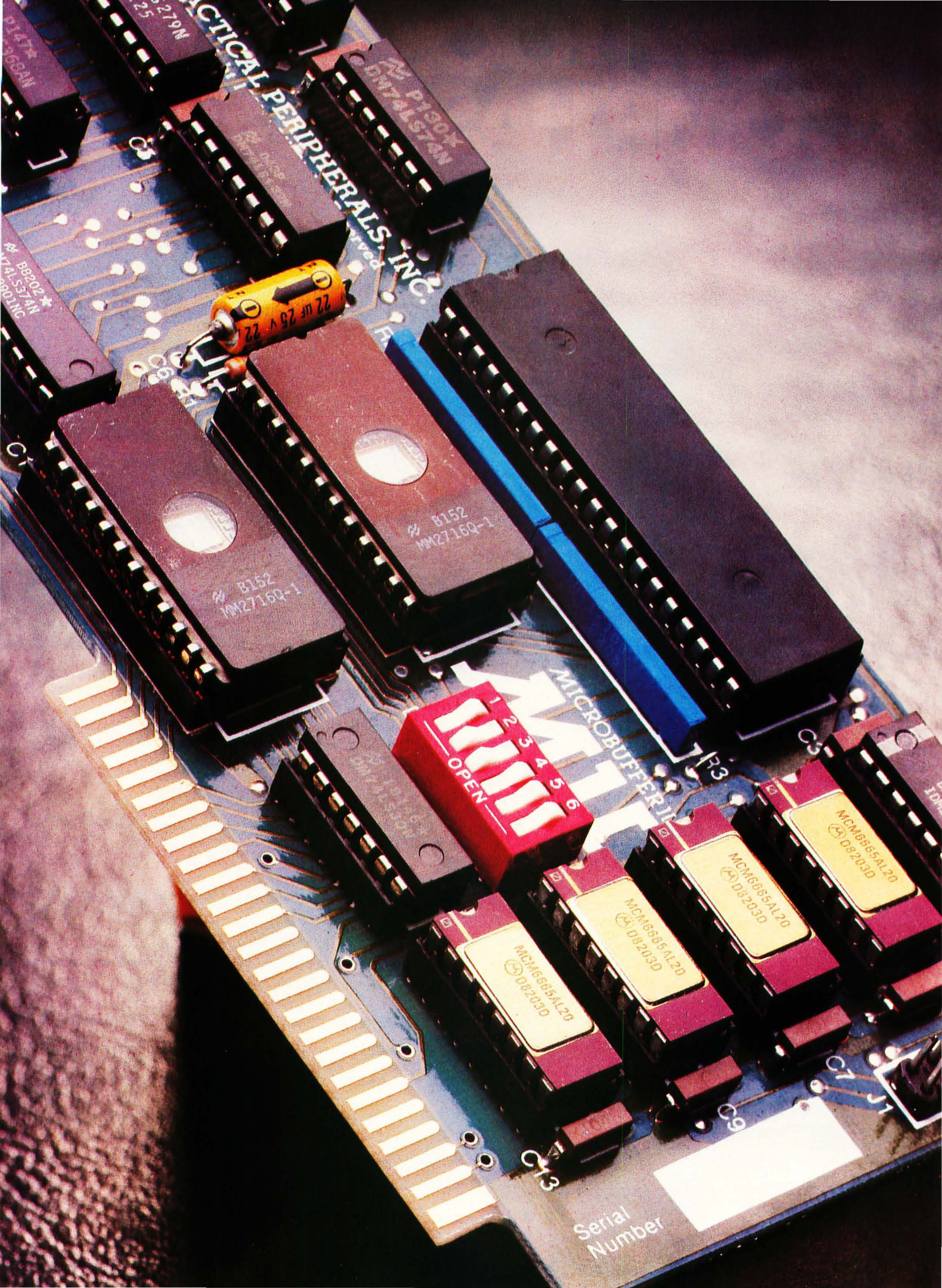
Summary

The TRS-80 Model 100 is an amazing machine. In one fell swoop, Radio Shack seems to have bypassed the "electronic cottage" and brought us the "electronic shopping bag."

Just out of curiosity I added up what it would roughly cost to buy the separate elements that make up the Model 100, that is, if you could buy them separately. There's the display, the keyboard, the processor, the memory, the modem, the RS-232C interface, the parallel printer interface, the clock/calendar, the cassette interface, the barcode-reader interface, the text editor, the BASIC interpreter, the communications program, and the address-book and appointment-calendar programs. My rough estimate comes to about $1500, and that doesn't include the tremendous amount of time you would have to spend getting all these things to work together. No matter what your feelings are about the software or the size of the memory or display, I think you'll agree that, at $999 for a 24K-byte RAM machine, the Model 100 is a pretty good bargain.

A few weeks ago a short note on the Model 100 was leaked by the *Wall Street Journal*. Rumor has it that at least one person saw this note, promptly ran down to the local Radio Shack store, and placed an $800 deposit in a very surprised salesperson's hands.

Radio Shack could probably make money issuing just a mediocre portable computer. Instead, it produced an exceptional machine. The designers of this machine—including Bill Walters of Radio Shack, Bill Gates of Microsoft, and several others at both companies—should be congratulated. And I have a feeling they will be—all the way to the bank. ■


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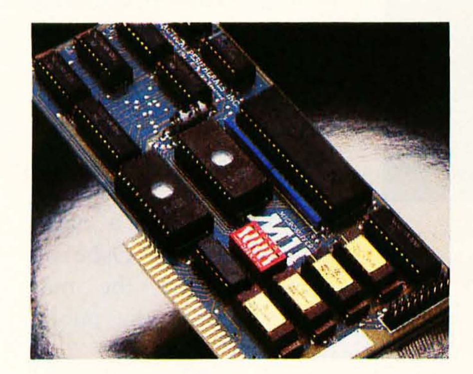
MICROBUFFER™ ALLOWS YOU TO PRINT AND PROCESS SIMULTANEOUSLY.

Microbuffer will instantly increase your efficiency — and eliminate the frustration of waiting for your slowpoke printer.

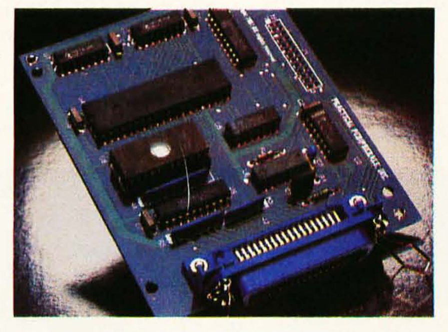
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FOR APPLE II COMPUTERS, Mircobuffer II features on-board firmware for text formatting and advanced graphics dump routines. Both serial and parallel versions have a power-efficient low-consumption design. Special functions include Basic listing formatter, self-test, buffer zap, and transparent and maintain modes. The 16K model is priced at $259 and the 32K, at $299.



FOR EPSON PRINTERS, Microbuffer/E comes in two serial versions — 8K or 16K (upgradable to 32K) — and two parallel versions — 16K or 32K (upgradable to 64K). The serial buffer supports both hardware handshaking and XON-XOFF software handshaking at baud rates up to 19,200. Both interfaces are compatible with standard Epson commands, including GRAFTRAX-80 and GRAFTRAX-80+. Prices range from $159 to $279.



ALL OTHER COMPUTER/PRINTER COMBINATIONS are served by the stand-alone Microbuffer In-line.

The serial stand-alone will support different input and output baud rates and different handshake protocol. Both serial and parallel versions are available in a 32K model at $299 or 64K for $349. Either can be user-upgraded to a total of 256K with 64K add-ons — just $179 each.

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Microbuffer II is slot-independent. It slips directly inside the Apple II in any slot except zero.

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The Osborne Executive and Executive II

Adam Osborne's Improved Portable Computers

Jerry Pournelle
c/o BYTE Publications
POB 372
Hancock, NH 03449

When the Osborne 1 burst on the scene there was plenty of speculation. Would it survive? Would people buy it despite the small screen and generally unaesthetic appearance?

It didn't take long for those questions to be answered. The Osborne 1 is now one of the top-selling personal computers and is identified with the idea of a "portable computer." Osborne Computer Corporation also pioneered the concept of including software worth more than the cost of the machine.

Osborne's second and third computers have been the subject of even more speculation, but this time people at Osborne feel that they've done it right. The Osborne Executive features a larger, 7-inch screen with 24 lines of 80 characters each, two thin double-density disk drives, 128K bytes of memory, both CP/M Plus and the UCSD p-System operating systems, and all the previously available software plus a new database management system, Personal Pearl. The Executive II has all of the above features and an 8088 coprocessor board with 128K bytes of its own memory, high-resolution monochrome graphics, both the MSDOS and CP/M-86 operating systems, and the ability to run IBM Personal Computer programs. If that isn't enough, there are still more options.



Photo 1: *The Osborne Executive with a 7-inch amber screen, two half-height disk drives, and the input/output connectors across the bottom front of the computer.*

Adam Osborne and the Osborne 1

I saw my first Osborne 1 computer when it was introduced at the West Coast Computer Faire two years ago. It's hard to remember just how radical an innovation the Osborne 1 was: a full Z80-based computer with the CP/M operating system, 64K bytes of memory, two 5¼-inch disk drives, a 5-inch screen with 24 lines of 52 characters each, a detachable keyboard, an RS-232C serial port and a parallel port, and plenty of software, all in one package for $1795. The programs given away with the machine were some of the microcomputer industry's best: Wordstar, the top-selling word-processing program; Supercalc, a Visicalc-like electronic spreadsheet; Microsoft BASIC, the standard BASIC; and CBASIC, a better business BASIC.

It looked like a natural—if Adam Osborne could produce the machines, and if the public would buy them.

Those issues weren't in doubt for long. The public had been waiting for an affordable, easy-to-use, business-quality computer. As the Osborne advertisements said, it was inevitable. The Osborne 1 soon had a major chunk of the market all to itself.

There followed a number of product improvements. An external video monitor was optional, for those who

At a Glance

Product Name
The Osborne Executive

Manufacturer
Osborne Computer Corporation
26538 Danti Court
Hayward, CA 94545

Price
$2495

Components
Size: width 20½ inches, depth 13 inches, height 9 inches
Weight: 28 pounds
Electrical needs: 120 or 230 volts AC, 50 or 60 Hz
Processor: 4-MHz Z80A
Memory: 128K bytes of user RAM
Display: 7-inch amber monitor; 24-line by 80-character memory-mapped screen, two sets of 128 characters; 8- by 10-dot character grid; writable character font; 12-bit display memory allows blinking, dim, underlined, reversed characters and/or alternate character set for each character
Keyboard: 69 keys for text and data entry, 12-key numeric keypad, 10 programmable function keys, 4 cursor control keys, redefinable keyboard layout, automatic repeat on all keys, detachable keyboard with coiled cable
Disk Drives: two half-height double-density 5¼-inch floppy-disk drives with 204K-byte storage capacity each, can read Osborne 1, IBM PC, DEC VT-180, Xerox 821, UCSD p-System, and Cromemco disk formats
Input/Output: two RS-232C serial ports for a modem and a printer, one parallel port configurable for IEEE 488 or Centronics-style accessories

Software Included
CP/M Plus (Digital Research) and UCSD p-System run-time (Softech Microsystems) operating systems, Wordstar (Micropro), Supercalc (Sorcim), MBASIC interpreter (Microsoft), CBASIC semi-compiler (Digital Research), and Personal Pearl (a database management program)

Options
300-bps direct-connect modem, battery pack

Alternate Configuration
Executive II with the standard features above plus the following: Coprocessor board with 4-MHz Intel 8088 microprocessor and 128K bytes of RAM expandable to 256K bytes, 640- by 200-dot high-resolution monochrome graphics, MSDOS (Microsoft) and CP/M-86 (Digital Research) operating systems, IBM Personal Computer compatibility, connector to external expansion bus
Price: $3195

didn't care for the tiny screen. A stylish redesigned case switched ugly-duckling brown for corporate blue and gray. Optional double-density disks offered 204K bytes instead of 102K bytes per disk, and the capability to read a wide variety of 5¼-inch disk formats was featured. An 80-column or 104-column screen format could be added. A modem and external battery pack were available. More software was bundled in; a copy of the popular database management program dBASE II was given away if you bought an Osborne 1 during the Christmas sales season. One particularly interesting accessory was the Start-Pack, a combination of flip charts, documents, and audio-cassette tapes that enable a rank beginner to turn on the Osborne 1 and learn to use it in hours. (I know that one works, because we tested it on my Boy Scout Computer Merit Badge class.)

Even with the improvements, the increased competition in the small computer field indicated that enhancements to the Osborne 1 wouldn't be enough; a more powerful computer was needed. Osborne had two logical choices: keep the size constant and add capabilities, or keep the capabilities constant and make the machine smaller.

Osborne chose the first route, and the Osborne Executive is the result.

The Executive

The Executive shares the same case and colors as the newer Osborne 1. It weighs 28 pounds, making it more *transportable* than portable; that is, it's too heavy for most people to carry around with them wherever they go. The first noticeable difference from the Osborne 1 is the screen, which is 7 inches across and amber in color. The character set is excellent, and with the larger screen each 8- by 10-dot character cell is very readable. An external video screen is provided for, but most users won't need one.

The designers gave the display system a lot of thought. Each character on the 24 by 80 memory-mapped screen has 12 bits of display memory to select blinking, dim, underlining, reverse video, and/or the alternate character set for each 7-bit ASCII (American National Standard Code for Information Interchange) character. Also, the entire display can be reversed to black on amber instead of amber on black. There are two sets of 128 characters, so an alternate character set could easily be defined to be italic, boldface, or even graphics characters. This feature is called a "writable character font" and has many visual possibilities. It's possible to have up to 256 different characters on the display, and you can define each character if you like. Default character sets are loaded from the disk into screen memory when the system is turned on or reset.

The 128 characters in the first character set are the same as the Osborne 1's with its 31 simple graphics characters. The alternate character set with an additional 128 characters will probably be TRS-80-style block graphics and possibly some Greek characters. A font-editor utility is supplied with the system to create your own characters.

The flexible terminal emulation program allows the Executive's keyboard and screen to imitate nearly any standard terminal. Although the Executive uses the same screen and cursor control codes as the Televideo 912 terminal, it can be made to act like the 10 to 15 other terminals in this program's menu.

The improved keyboard with its 69 keys and 12-key

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numeric keypad still doesn't have keys for the entire set of ASCII characters, but as with the present Osborne 1, combinations of keys will produce characters such as the curly braces ({ }) and the tilde(~). However, the entire keyboard is software programmable to let you devise and install any keyboard layout you want. There are also 10 user-programmable function keys (control-0 through control-9) and four fixed-function keys (the cursor keys).

The slim-line disk drives to the left of the video screen are another striking feature of the new Osborne Executive. These half-height 5¼-inch disk drives are double-density but only single-sided. The company has been unable to find portable double-sided drives that meet its requirements of reliability and price. Storing information in the Osborne double-density format allows for 204K bytes on a disk.

Meanwhile, the Executive reads a wide variety of disk formats including, naturally, single- and double-density disks from the Osborne 1, but also formats as diverse as the IBM Personal Computer, DEC VT-180, Xerox 821, UCSD p-System, and Cromemco mini-disk.

The standard Executive uses a Z80A microprocessor running at 4 MHz and comes with 128K bytes of RAM (random-access read/write memory) plus 10K bytes of internally-used memory for power-on diagnostics, I/O drivers, and a scratch-pad area. A Zilog SIO chip provides two serial ports where the Osborne 1 had only one. The input/output is now sent to ports instead of being memory-mapped. The standard operating system will be CP/M Version 3.0, also known as CP/M Plus, but the UCSD p-System run-time operating system will be provided as well. (The UCSD Pascal language is extra.) The additional memory beyond the 64K bytes addressable by the Z80 microprocessor is managed by CP/M Plus to allow, for example, larger disk-buffer areas for significantly faster operation. A clock keeps track of the time and date, but only while the power is turned on. A small fan cools the computer.

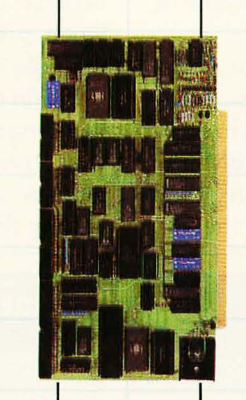
The connectors and controls on the front of the machine are the two RS-232C serial ports (typically for a modem and printer), a parallel port that can be configured for either IEEE-488 or Centronics-style use, video brightness and contrast, external video, the reset button, an RCA jack for composite video output (so you don't need an adapter), and the blue power switch. The grill on the right front hides the power supply.

You won't see a battery-power connector on the front of the machine because Osborne plans to offer an optional battery pack with a 12-volt DC to 220-volt DC converter that the Executive's power cord can plug directly into. The connector for the converter plugs into the battery pack or your car's cigarette lighter. (Running the car while the computer is plugged in is not recommended due to voltage spikes.) Jumpers on the back of the Executive allow overseas use of the machine with international voltages.

Another available option is a small 300-bps (bits per second) direct-connect modem that slides into the slot,

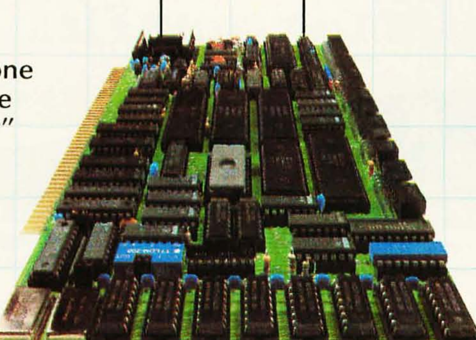
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normally used for storing disks, below the disk drives. A short cable leads to the DB-25 connector directly below (labeled "Modem"). The power for the modem comes from one of the connector's pins. The modem option is intended to help make the Executive a full computer, capable of communications and nearly any job a microcomputer can do.

The software package with the Executive includes the standard items Osborne offers (Wordstar, Supercalc, MBASIC, and CBASIC), the two operating systems (CP/M Plus and UCSD p-System), and some other goodies like Personal Pearl, a database management package.

Osborne is focusing on office productivity tools and will be offering three synchronous communications packages to make communications with the company mainframe or minicomputer easier. The first package is for IBM 3270 terminal emulation; the second has IBM 3780, 2780, and 3741 protocols; the third is for the X.25 protocol. Site licenses for each package will cost about $1000 but will allow you to use the programs on a number of Executives at one location.

The Executive II

Interestingly, the designers made provisions for the Executive to become an IBM Personal Computer work-alike. The Executive II is an upgraded Executive with a piggyback coprocessor board inside that contains a 16-bit Intel 8088 microprocessor and 128K bytes of memory for its use and provides 640- by 200-dot monochrome graphics. With this board, the machine should be able to run most IBM PC applications programs.

The MSDOS and CP/M-86 operating systems come with the Executive II, so IBM compatibility is assured at the operating-system, disk-format, and monochrome-graphics levels. As long as programs for the IBM PC don't use special knowledge of the IBM hardware, they should run fine on the Executive II. However, the Executive II does not copy the IBM PC input/output structure exactly.

The IBM Personal Computer disk format is directly supported by MSDOS on the Executive II, so you can just slip in a disk for the PC and run the programs or read the data. Osborne does not offer any 16-bit programs for the Executive II other than the operating systems. You can buy programs in the IBM PC disk format from existing software distributors and computer stores.

One incompatibility in the system is that you can't share memory between the different processors; they each have their own 128K bytes of RAM. However, the Z80 does handle input/output when the 8088 is in control.

You can expand the memory for the 8088 up to 256K bytes simply by filling the rest of the sockets on the coprocessor board with 64K-bit RAM chips. For real memory expandability, just wait until 256K-bit RAM chips become economical. The coprocessor board has a jumper for operation with these chips to give you 1 megabyte of memory in your portable Executive II. If you want color or other IBM accessories, the coprocessor board has a connector for an IBM-compatible expansion bus like the Tecmar PC-Mate.

"When we announce the Executive," Adam Osborne says, "we'll have several thousand in distributors' warehouses. Customers will be able to buy our machines as soon as they've heard about them." You will have to wait a month after the Executive's introduction for the Executive II to be available. A few months later, you will be able to upgrade an Executive into the Executive II when production settles down. Also, the price on the upgrade has not been set.

I didn't get to play with the machines very long, but I liked everything I saw. At $2495 and $3195, the Osborne Executive and Executive II are going to be major contenders in the microcomputer market, and not just among the portables, either. ■

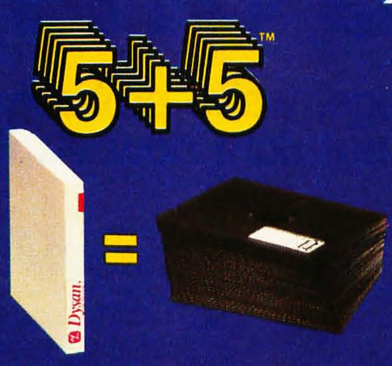
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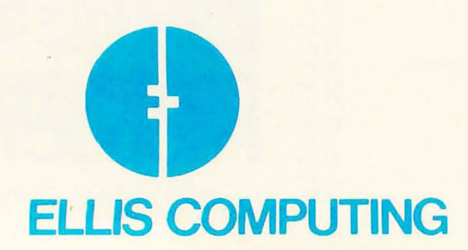
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Build an RS-232C Code-Activated Switch

This device will let you switch between several peripherals connected to one serial port.

Steve Ciarcia
POB 582
Glastonbury, CT 06033

Do you ever find yourself probing through a mass of tangled cables behind your computer? If your computer is like mine, you probably have only one serial port, to which you have to connect both a printer and modem. Of course, whenever you want to use a different peripheral, you have to unplug one and plug in the other.

The variety of peripheral devices necessary to gain full use of a personal computer can create a connection jam at the serial port. Many small computer systems have two I/O (input/output) ports intended to support a printer and modem. Usually the port intended for connection to the printer is a parallel port (although many printers require a serial port), while a serial port (perhaps called a "communications port") is provided for connection to a modem. For the typical user, this may be adequate.

Z8 is a trademark of Zilog Inc.
Special thanks to Bill Curlew for his Z8-programming expertise.

Some of us, however, aren't typical users; we have more than one printer and one modem attached to our computer, or our printer uses a serial interface, not a parallel one. I have three serial printers and two modems, all of which I must connect to my workhorse computer system through a single RS-232C serial port. (It's not that my computer is a small configuration: it has eight parallel ports in addition to the one serial port. It's just that every new peripheral device I buy seems to be serially interfaced, and I can't fit any more serial ports inside the already crowded enclosure.

Recently, while juggling three cables and leaning over the computer, I began to wish for an easier way to switch between devices. I wondered if I could just put together a little box containing a multiple-pole rotary switch wired to a few DB-25 connectors as a workable compromise. But then I thought of a possible better solution as I remembered something I had seen in a catalog of data-communication products: a device called a code-activated switch.

Functional Analysis

The function we need here is the ability to multiplex—switch between as needed—several peripheral devices connected to a single I/O channel. A *communications multiplexer* performs this function. In essence, this device forms a bridge in the communication link between the master device (usually the host computer's I/O port) and one of several slave devices; transfer of data can proceed in either direction over this bridge. The physical linking of the input and output can be accomplished either mechanically or electronically.

Two Approaches to Switching

The simplest possible device for the purpose is a four-position mechanical switch box. Available commercially for about $150, a DB-25 switch box allows you to select one of four peripherals for output by turning a four-position multipole rotary switch. This manually activated switch is most frequently used where the peripherals, computer, and operator are in close proximity. Its major advantage is its relative low cost.

Unfortunately, mechanical switches are subject to deterioration from the elements and, of course, require a human operator to function. Harsh environments call for fully electronic switches. In situations where the communicating devices are at great distances from the computer, some

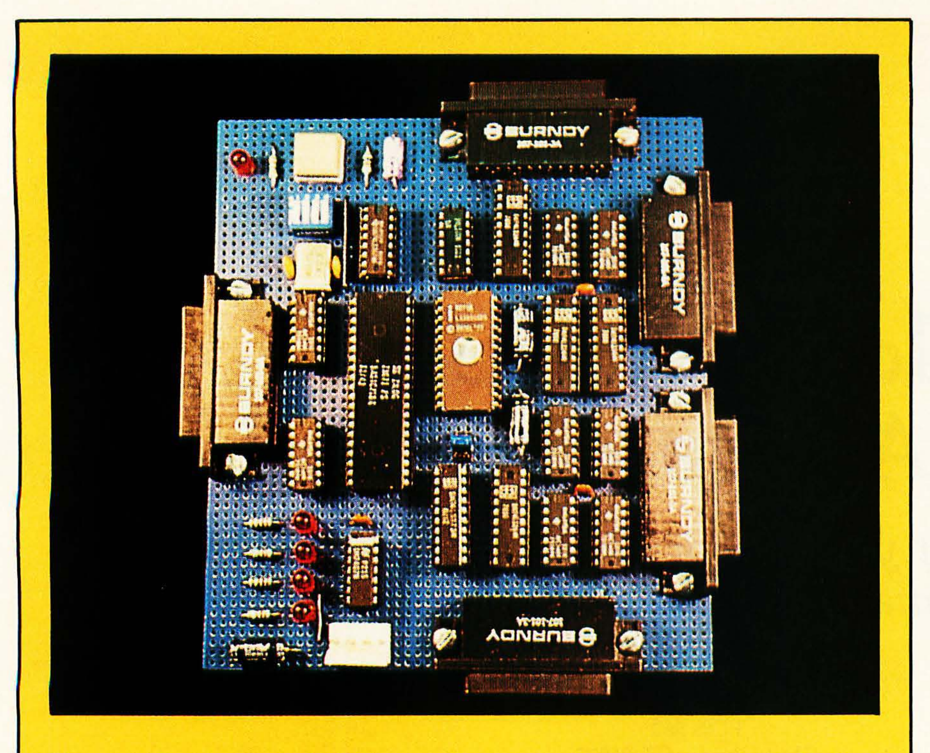


Photo 1: *Prototype of the Micromux four-channel code-activated switch, built around a Zilog Z8 single-chip microcomputer.*

form of remote-controlled switch must be used. An ordinary electrical relay can provide remote control, but the greatest flexibility and reliability are obtained from a fully electronic, software-controlled, code-activated peripheral-device switch. Let's look at some of the possibilities.

Electronic Switches

Figure 1a is a simple block diagram of a four-channel electronic RS-232C multiplexer switch. The master input on the left side is intended to be connected to a computer's I/O port and the four channels on the right side are intended to be connected to four peripheral devices. (In the following discussion, the assumption will be that data is being transmitted by the master device to one of the slave devices, although data can also move in the other direction.)

On the left side of the electronic multiplexer, the input serial data from the master device (the computer) is converted from RS-232C

Figure 1a: *Block diagram of a four-channel peripheral switch for RS-232C serial communication, which may be controlled via wired remote activation or code activation.*

voltage levels (±15 V) to TTL (transistor-transistor logic) voltage levels (0 to +5 V) and directed to the inputs of four three-state signal buffers (also known as three-state switches) wired in parallel.

Each three-state signal buffer has an active-low enable input. An input voltage of 0 V on this enable input line allows a signal to pass through the buffer. When any one of the four buffers is enabled, the master device's input signal is allowed to pass through it. This signal is then reconverted to RS-232C levels and sent on to the peripheral. Changing the active-low enable signal from the first three-state signal buffer to another diverts the output to a different peripheral device. (In this particular configuration, only one of the four buffers should be activated at one time. Other setups could allow output to be sent to two, three, or all four of the output buffers.)

The method by which the enable lines of the three-state signal buffers are activated determines the complexity of the electronic switch. Two particularly important types of control methods are used by devices called remote-activated switches and code-activated switches.

Both remote- and code-activated switches are designed for hands-off operation. The difference between them is this: selection of an output channel is done in the former by decoding separately conveyed logic-signal inputs and in the latter by decoding signals conveyed as part of the data being transmitted through the multiplexer switch.

In the case of the *remote-activated switch*, wires for the remote-control signals must be provided in addition to the serial data connection. Furthermore, if the switch is located some distance from the computer, it may be necessary to add line drivers and receivers to these control lines. In the example control circuit shown in figure 1b, only three wires (plus ground) and a single type-74LS155 integrated circuit (a two- to four-line demultiplexer) are required to provide the enable signals to the four buffers. Two of the wires select one of the four control outputs; the third wire serves as a switch-enable line, selecting output from one buffer or none.

(1b)

Figure 1b: *Functional diagram of a 74LS155 two- to four-line demultiplexer as it would be connected in a peripheral switch using wired remote activation.*

In principle, remote-activated switches are not much more complicated than their mechanical equivalents. They are generally cost-effective where high speed is essential or where there are tens of channels with various selection configurations. On the negative side, remote-activated switches require hardware and software control interfacing and are not easily adapted to different computers.

The Code-Activated Switch

The *code-activated switch* uses a microprocessor to analyze the characters in the data flowing through the switch. When a particular character or series of characters is received, the microprocessor turns output channels on or off. The only connection between the host computer and the multiplexer is the master input serial line.

Code-activated switches are available with various levels of complexity. The simplest ones merely switch channels upon recognizing a certain code sequence. More sophisticated units can accept incoming data at one data rate, collect it in a memory buffer, and send it to an output channel at another data rate. The most sophisticated units function more as message switchers and data concentrators than multiplexers, allowing party-line conversations and priority-interrupted communications.

Rather than confuse the issue by explaining all the various hardware categories, I've chosen as this month's project an "intelligent" (at least microprocessor-controlled) but rather simple code-activated switch that I call the Micromux. I hope you'll take the opportunity to build it and experiment with it. While useful as a printer or modem switch, this code-activated switch may perhaps find more demanding applications such as message channeling and data acquisition.

Build the Micromux

The intelligence of the Micromux, which is used to decode characters from the serial data, could have been provided by virtually any microprocessor. The only requirement is that the system contain a program-storage area and both a parallel and serial I/O port (the former to send enable signals to the three-state signal buffers, the latter to read and transmit serial data). While I could have chosen a general-purpose microprocessor such as the 6502 or Z80 and then used PIO (parallel input/output) and SIO (serial input/output) adapters, I chose to use the Z8671 variant of the Zilog Z8 single-chip microcomputer to reduce the complexity of the project. The Z8671 was the basis for my Z8-BASIC Microcomputer project (see reference 1) and the new Z8-BASIC System-Controller board available from The Micromint. The connections needed

(1c)

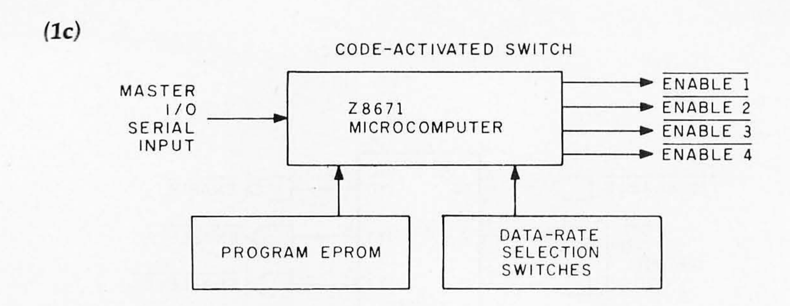


Figure 1c: *Functional diagram of a Z8671 microcomputer chip (variant of a Zilog Z8) as it would be used to control a four-channel code-activated peripheral switch.*

Number	Type	+5V	GND	−12V	+12V
IC1	Z8671	1	11		
IC2	2716/32	24	12		
IC3	74LS373	20	10		
IC4	74LS367	16	8		
IC5	74LS10	14	7		
IC6	74LS244	20	10		
IC7	MC1489	14	7		
IC8	MC1488		7	1	14
IC9	7407	14	7		

Table 1: *Power connections for the integrated circuits of figure 2.*

by the Z8671 to control the four-channel switch are shown in figure 1c.

Much of the hardware and many of the software subroutines required for the task are built into the Z8671 already. This Zilog product contains 256 bytes of RAM (random-access read/write memory), a serial port, two counter/timers, two parallel ports, and a 2K-byte tiny-BASIC (BASIC/Debug) interpreter within a single integrated-circuit package. Combined with a type-2716 EPROM (erasable programmable read-only memory) and a data-rate-selection switch, the five-chip Z8-BASIC Microcomputer system can be easily programmed to monitor RS-232C serial communications and switch channels on cue. The control program can be written in either BASIC or assembled machine language, as you will see.

Figure 2 on page 53 is the schematic diagram of the Micromux. IC1 is the Z8671. Its serial input line (SI) is tied directly to the data input of the master input channel (RD). Four of the Z8671's port-2 output lines serve as the enable inputs to the three-state signal buffers. The program that controls the computer and analyzes the data transmissions has been written into the 2716 EPROM, IC2. IC3 is an 8-bit latch which holds the 8 low-order address bits (from the Z8's multiplexed outputs) during memory and I/O operations. IC5 is configured as a memory-mapped address decoder that enables IC4 when any address over hexadecimal C000 is accessed.

The data rate is selected by the switch settings on the input of IC4. When the system is powered up, these data-rate switches are read (as memory location hexadecimal FFFE) and used to set a counter/timer that divides the signal from the 7.3728-MHz crystal. The data rates that may be thus selected include 110, 150, 300, 1200, 2400, 4800, and 9600 bps (bits per second).

The integrated circuits IC6 through IC9 are type-74LS244 three-state signal buffers. Nothing flows through them unless their active-low enable lines, pins 1 and 19, are at logic 0. IC18 is a type-7407 buffer/driver, which lights one of four LEDs (light-emitting diodes) to show the enabled channel.

RS-232C drivers and receivers are provided, appearing in the schematic as IC10 through IC17. I chose to use only the six most frequently used RS-232C communication signals in this circuit. If you need additional signals, then you'll have to include more three-state signal buffers and driver/receivers. Conversely, if you need only Received Data and Transmitted Data (pins 2 and 3), then you'll need fewer chips in your code-activated switch. (Six signals—Received Data, Transmitted Data, Clear to Send, Ready to Send, Data Set Ready, and Data Terminal Ready—were as many as I was willing to wire by hand.)

Programming the Micromux

The Z8671 can be programmed in either tiny BASIC or assembly language. The primary difference is speed. With the Z8671 set to receive data at 9600 bps, only a machine-language program would execute fast enough to digest the data and make control decisions at that rate. But for slower data rates where there is more time for the processor to react, using BASIC makes the programming task easier.

For a multiplexer to switch quickly between four different output channels, four distinct character codes are required. These codes can be single ASCII (American National Standard Code for Information Interchange) characters such as the letters A, B, C, and D or sequences of characters such as "$%&1", "$%&2", "$%&3", and "$%&4". However, because the code-activated switch relies upon the data stream to contain its control codes, it's important that the channel-activation codes be different from any character sequences appearing in the data transmissions, or false channel selection may occur. Obviously, we would not choose the letter A as a practical selection code in most applications, so we choose some multicharacter sequence that would be unlikely to appear. For instance, you would probably never need to print the sequence "$%&1", and it could be used to designate a switch to a printer connected to output channel 1. Similarly, "$%&4" would enable channel 4.

Because the sequence-recognition time is dependent on the code length, an alternative is to use single *nonprinting* characters such as Control-A or Control-D. A single-character switch-control code is recognized faster than a three- or four-character code. When using a machine-language program running at 8 MHz the difference is hardly significant, but in BASIC the difference could be considerable.

Micromux Control in BASIC

At this point, let's look at how the

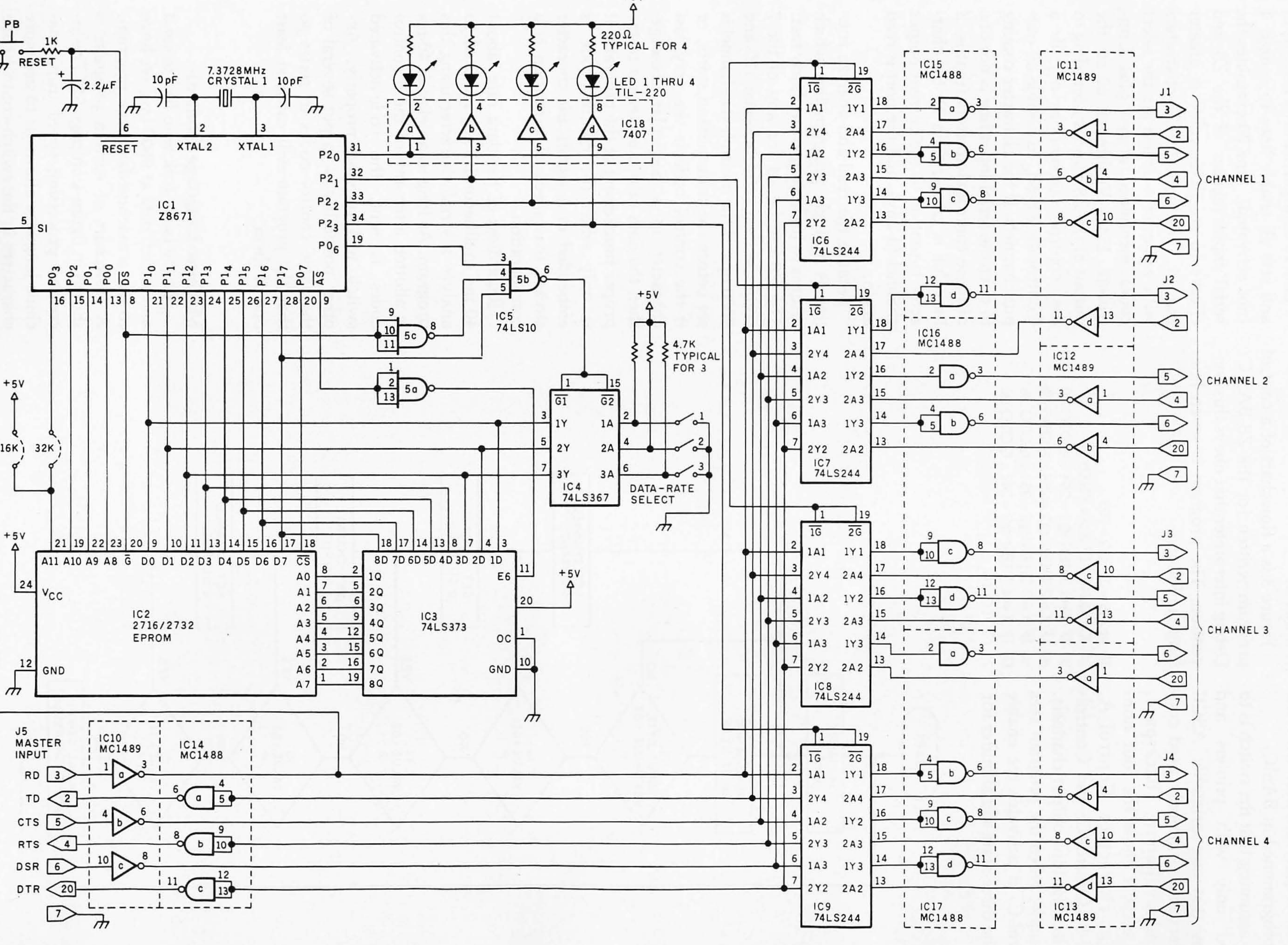


Figure 2: *Schematic diagram of the Micromux prototype four-channel code-activated switch. This design uses a Z8671 as a controller to monitor codes embedded in the transmitted data and activate the appropriate signal buffer for the channel. Only the six most used RS-232C signals are wired here; the addition of more buffer chips would allow switching of more RS-232C signals. Power connections are shown in table 1 on page 52.*

Micromux might function with the Z8671 programmed in BASIC.

First, assuming that the switch is to be used only with printers and modems that use printable ASCII characters and commonly used control codes (Return, Backspace, Delete, etc.), I chose the four nonprinting characters Control-A, Control-B, Control-C, and Control-D to select the four output channels. For example, when the program sees a Control-C, it activates the enable line to the three-state signal buffer for channel 3.

Figure 3 is a flowchart of a control program written for the Z8-BASIC/Debug interpreter that obeys this convention. The program is seven lines long, as follows:

```
10 @246=0 : @2=255
20 X=@240 : IF X>4 THEN 20
30 IF X=1 THEN @2=254 : GOTO 20
40 IF X=2 THEN @2=253 : GOTO 20
50 IF X=3 THEN @2=251 : GOTO 20
60 IF X=4 THEN @2=247 : GOTO 20
70 GOTO 10
```

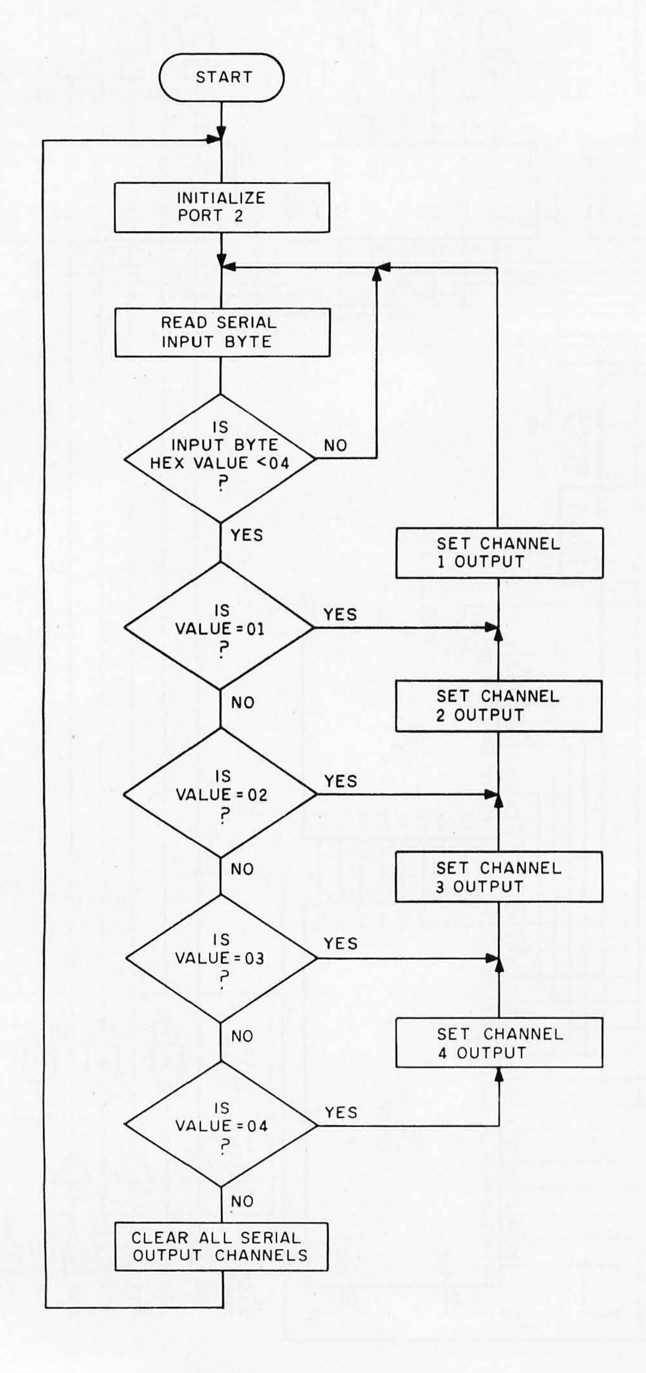


Figure 3: *Flowchart of a Z8-BASIC/Debug program to control the four-channel code-activated switch at low data rates.*

Line 10 configures port 2 for output and sets all enable lines to a logic 1 (not activated). Line 20 examines the serial input register of the Z8 and checks to see if its value is greater than 4. The only ASCII characters with values of 4 or less are the select codes mentioned above plus Control-@. Lines 30 through 60 set the output of the Z8's port 2 according to the control convention or, if a Control-@ is read, to disable all output channels. If the character coming in over the serial input line is not one of these control characters (that is, if its value is greater than 4), the character is sent on to the current output channel (if any), and the port is read again.

Because the read-and-analyze routine is a single program line which returns to itself, it operates fairly fast. The Z8 can be set for any of the 7 common data rates between 110 and 9600 bps. If the multiplexer channel is set before the transmission starts, or if the control code is the very last character in a particular message, then the data rate is irrelevant to the proper functioning of the program. It is only when the control code is embedded in a significant character stream that speed of execution is a consideration.

Regardless of the data rate, about 40 ms (milliseconds) are required to analyze a serial character using this program. As long as a delay of 40 ms is allotted after any of the 5 control codes is sent, the code-activated switch will respond properly. Another possibility is to put several of the same control codes in series so that the program will catch at least one of them.

Machine-Language Control

For the hasty folk who like to send and switch data at 9600 bps, we have to use a machine-language program. A flowchart of such a program is shown in figure 4 on page 55. The increased processing speed using machine language allows us to use more characters in the switch-control code sequence and lessens the likelihood of confusion with data passing through the switch.

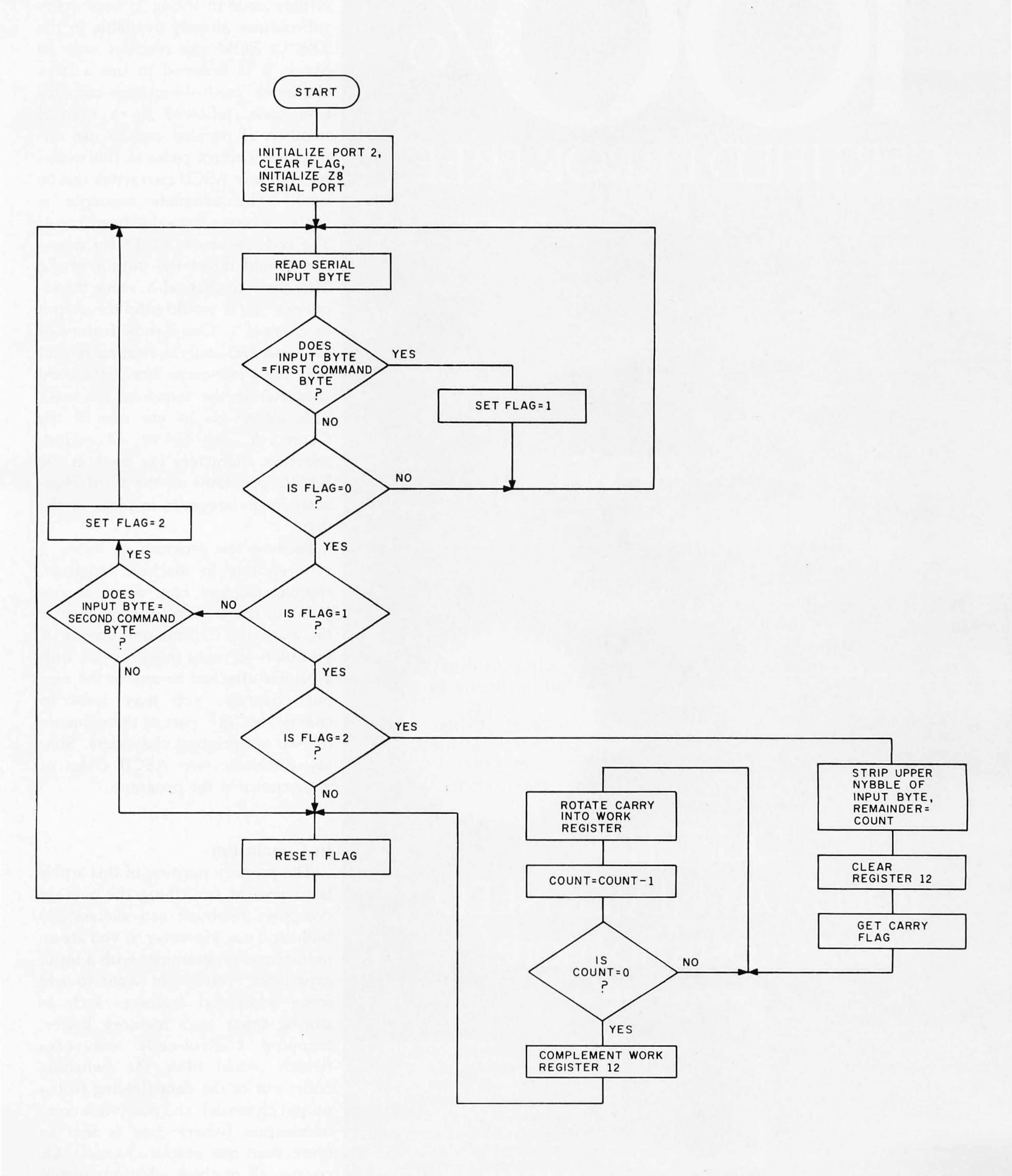


Figure 4: *Flowchart of a Z8 machine-language program that can control the code-activated switch at data rates up to 9600 bps.*

The final program, shown as assembly code in listing 1, uses many subroutines already available in the Z8671's ROM and requires only 88 bytes. It is designed to use a two-character control-sequence-recognition code, followed by a channel number. (I decided not to use unprintable control codes in this example, but any ASCII characters can be used.) The complete sequence is "@!*x*", where *x* is a value from 1 to 4. The code sequence "@!3", for example, would direct the output of the Micromux to channel 3, while the sequence "@!1" would send the output to channel 1. One handy feature of the read-and-analyze routine is that only the 4 low-order bits of the third character in the sequence are used. This allows us to use one of the Control-A, -B, -C, or -D output-selection characters (as used in the BASIC program) as the third character in the sequence in place of the digit.

Because the program of listing 1 runs entirely in machine language, channel changes may occur at any point in the transmission, at any of the available transmission speeds. If you plan on using this program with a printer attached to one of the output channels, you may want to change the "@!" part of the sequence to two nonprinting characters. Simply substitute two ASCII codes of your choice in the program.

In Conclusion

The primary purpose of this article is to present something the average computer hobbyist can successfully build and use. However, if you are an industrious programmer with a lot of experience, you might want to add some additional features, such as storing input in a memory buffer, trapping control-code sequences (which would filter the switching codes out of the data flowing to the output channels), and party-line communication (where data is sent to more than one output channel). Of course, all of these additions would have involved more complex hardware and software.

In my own case, the Micromux

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didn't end up attached to a printer. I'm using the prototype, consisting mostly of a modified Z8-BASIC Microcomputer, to communicate with four other Z8 boards that perform specific control and security assignments, none of which I had previously deemed important enough to merit tying up four separate serial ports.

Now, of course, I need another code-activated switch for the printers and modems, but I'm not enthusiastic about hand-wiring another one. So if The Micromint decides to make an improved version of the Micromux, I'll take the first one off the assembly line. ■

Listing 1: *Machine-language program for the Z8671 to control the code-activated switch at data rates up to 9600 bps.*

```
1000                 ;
1000                 ;
1000                 ;  MULTIPLEXER SWITCHING PROGRAM FOR THE
1000                 ;  ZILOG Z8 MICROPROCESSOR, P/N Z8671 WITH
1000                 ;  ON-BOARD BASIC/DEBUG ROM
1000                 ;
1000                 ;  READ A TWO BYTE CODE AND THEN SET THE
1000                 ;  PORT 2 CONTROL BITS AS REQUIRED BY
1000                 ;  THE THIRD (DATA) BYTE.
1000                 ;
1000                 ;  USES ROM CALL TO READ BYTES ON THE SERIAL
1000                 ;  PORT OF THE Z-8 COMPUTER BOARD.
1000                 ;
1000                 ;   TO CHANGE CONTROL BYTES, STORE FIRST COMMAND
1000                 ;   AT 1041H, SECOND COMMAND AT 1055H. YOU MUST
1000                 ;   USE DIFFERENT CODES FOR CMD1 AND CMD2, DUE TO THE
1000                 ;   UNCONDITIONAL FLAG SET AFTER THE "FIRST" LABEL.
1000                 ;
1000                 ;
1000                 ; FIRST SET THE FIRST 20H BYTES TO 0FFH. THESE ARE THE
1000                 ; INTERRUPT VECTORS, AND ARE UNUSED BY THIS PROGRAM.
1000                 ;
1000                 ;
1000                 FILL    EQU     1000H
1000 FF FF FF FF FF          DB      #0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH
     FF FF FF
1008 FF FF FF FF FF          DB      #0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH
     FF FF FF
1010 FF FF FF FF FF          DB      #0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH
     FF FF FF
1018 FF FF FF FF FF          DB      #0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH,#0FFH
     FF FF FF
1020                 ;
1020                 ;
1020                 BASIC   ORG     1020H           ; PLACE A BASIC LINE AT 1020H
1020 00 0A 47 4F 20          DB      #0,#10,'GO @%1030',#0,#0FFH,#0FFH,#0FFH
     40 25 31 30 33
     30 00 FF FF FF
102F                 ;
102F                 ;
102F                 MULTI   ORG     1030H
1030 E6 F6 00                LD      246,#0          ; SET UP PORT 2 AS OUTPUT
1033 E6 F7 C1                LD      247,#0C1H       ; 7 BITS, ODD PARITY, 1 STOP, PORT 2 P
ULLUPS ON.
1036 E6 02 FF                LD      2,#0FFH         ; SHUT DOWN ALL I/O AT START
1039 E6 30 00                LD      30H,#0          ; SET FLAG TO 0
103C                 ;
103C                 ;
103C D6 00 54        CMAND   CALL    #0054H          ; GET A BYTE FROM THE SERIAL PORT
103F A6 13 40                CP      13H,#CMD1       ; IS THIS THE FIRST COMMAND CODE ?
1042 6B 05                   JR      Z,FIRST         ; YES, DO SET FLAG
1044 A6 30 00                CP      30H,#0          ; IS FLAG 0 ?
1047 EB 05                   JR      NZ,PART2        ; NO, TEST FLAG SOME MORE
1049 E6 30 01        FIRST   LD      30H,#1          ; SET FLAG TO 1
104C 8B EE                   JR      CMAND           ; AND GO BACK TO LINE
104E A6 30 01        PART2   CP      30H,#1          ; IS FLAG A 1 ?
1051 EB 0A                   JR      NZ,PART3        ; NO, CHECK LAST POSSIBLE FLAG SET
1053 A6 13 21                CP      13H,#CMD2       ; YES. IS THIS COMMAND BYTE 2 ?
1056 EB 1B                   JR      NZ,RESET        ; NO, FALSE ALARM. RESET FLAG BYTE
1058 E6 30 02                LD      30H,#2          ; YES, UPDATE FLAG
105B 8B DF                   JR      CMAND           ; AND GO BACK TO LINE
105D A6 30 02        PART3   CP      30H,#2          ; IS FLAG A 2 ?
1060 EB 11                   JR      NZ,RESET        ; NO. FALSE ALARM. RESET FLAG BYTE
1062 B0 12                   CLR     12H             ; CLEAR REG 12H
1064 DF                      SCF                     ; SET CARRY FLAG
1065 56 13 0F                AND     13H,#0FH        ; MASK OFF H.O. BYTE OF DATA
1068 10 12           LOOP    RLC     12H             ; ROTATE BIT ONCE.
106A 00 13                   DEC     13H             ; COUNT=COUNT-1
106C EB FA                   JR      NZ,LOOP
106E 60 12                   COM     12H             ; COMPLEMENT BECAUSE 0 = ENABLE TO CI
RCUIT
1070 E4 12 02                LD      2,12H           ; WRITE BIT TO THE MUX CONTROL PORT
1073 E6 30 00        RESET   LD      30H,#0          ; RESET COMMAND FLAG
1076 8B C4                   JR      CMAND           ; AND GO BACK TO LINE
1078                 ;
1078                 ;
1078                 CMD1    EQU     '@'
1078                 CMD2    EQU     '!'
1078                 ;
1078                 ZZZZ    END

SYMBOL TABLE

BASIC 1020   CMAND 103C   CMD1  0040   CMD2  0021   FILL  1000
FIRST 1049   LOOP  1068   MULTI 1030   PART2 104E   PART3 105D
RESET 1073   ZZZZ  1078
```

Next Month:

New developments in technology have prompted yet another speech-synthesis project, this one using adaptive differential pulse-code modulation.

Reference

1. Ciarcia, Steve. "Build a Z8-Based Control Computer with BASIC, Part 1," July 1981 BYTE, page 38. Part 2, August 1981 BYTE, page 50. Reprinted in *Ciarcia's Circuit Cellar, Volume III*. Peterborough, NH: BYTE Books, 1982.

To receive a complete list of Ciarcia's Circuit Cellar project kits available from The Micromint, circle 100 on the reader service inquiry card at the back of the magazine.

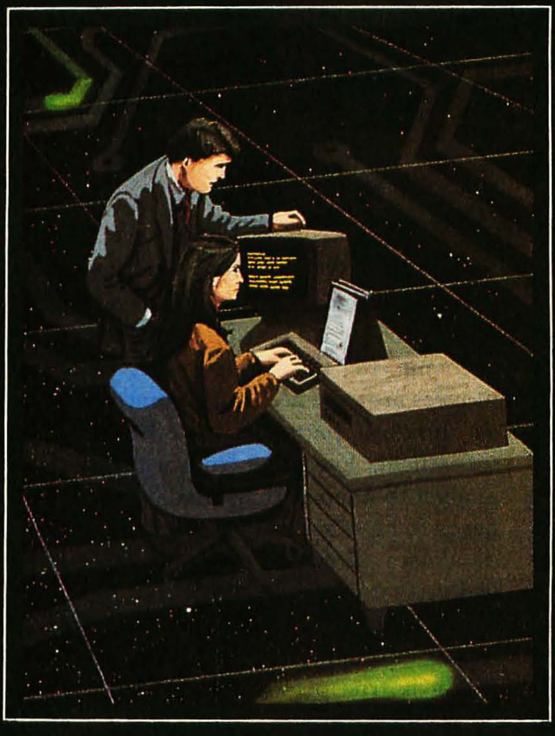
Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains the articles that were published from July 1980 through December 1981.*

If you would like to put together a code-activated switch from off-the-shelf components, you could configure powerful hardware using the new Z8-BASIC System-Controller board (which contains RAM, EPROM, and a Z8671 on board) and a few Z8-BASIC Serial Expansion boards. For information about availability and prices of the Z8671 or other Z8-BASIC board products, contact The Micromint Inc., 561 Willow Ave., Cedarhurst, NY 11596, (800) 645-3479.

The Electronic Office

by Pamela A. Clark, Managing Editor



The term electronic office has been overused to the point where one might believe that the complete electronic office does in fact exist. Nothing could be farther from the truth. While many office tasks are indeed automated—dedicated-function machines share data and a few peripherals—you could hardly say the electronic office is in full bloom. The current level of electronic office automation represents only a very small number of the myriad functions within an entire organization that could benefit from the speed and efficiency of the microprocessor. Companies strongly committed to implementing the electronic office will find the task complicated by the very nature of the change, as well as by confusion in the marketplace.

In the words of Marshall McLuhan, the medium is the message, and electronic transfer of information will profoundly affect the structure and management of an organization. If information is power, then distributed information means distributed power—a new and threatening concept for many companies. Management by divisional competition and conflict must give way to cooperative management as information is shared rather than controlled. Technological advances always create changes in staff hierarchy, performance standards, and human relations. Organization charts may soon reflect more tenets of communication theory than management theory as the organizational functions become inextricably linked to information management. The answer to the fundamental question, "Who has the authority to make changes in a shared database?" could restructure an entire corporation and postpone its electronic birth for a number of years.

The delayed emergence of the electronic office can also be traced to confusing signals from the technical arena. Traditional mainframe vendors tout powerful dedicated systems, but can't deliver the stand-alone features of a workstation, a situation that only perpetuates centralized resources and information. PBX vendors provide excellent low-speed voice and data local networks to channel information throughout a building, but have only recently begun to supplement this with terminals and software. The proliferation of microcomputers increases the impetus for change, but system incompatibility hinders electronic reorganization. The usefulness of *integrated* software packages remains limited by general-purpose designs aimed at large markets.

Organizations in search of electronic nirvana must still look to multiple vendors for discrete components. Rapid technological changes and the accompanying lag in industry standards combine to sustain that situation and keep the complete, integrated electronic office from realization. However, the entrance of industry giants AT&T and IBM brings a powerful new pressure on the market. These heavyweights have the necessary resources to tackle the many disciplines embodied in the electronic office. The level of technical integration required for a fully functional system is colossal. While the electronic office promoted by these giants may not be as innovative as current speculation would have it, it will be integrated. And if the electronic office is to become a reality, harmony must be the bottom line.

Our theme articles, beginning on page 60, are as diverse and discrete as components in the electronic office. Networks, individual computer systems, and software applications all play an important role in today's office. However, the total electronic office remains only a vision on the horizon. ■

Local Area Networks

An Update on Microcomputers in the Office

The boom in office communication systems is creating a pressing need for standardization.

Harry Saal
Nestar Systems Inc.
2585 East Bayshore Rd.
Palo Alto, CA 94303

The ideal state of computing—in which any computer or office device can communicate with any other device—is still on the horizon. But sharing information between physically separated personal computers, corporate computers, expensive printers, and disk drives is becoming more feasible and desirable every working day.

Often the information that managers would like to analyze with their electronic spreadsheet programs is ready and waiting on databases on the company mainframe computer, waiting for an easy communications link to the workspace in the managers' desktop computers. Electronic mail will help usher in a new era of office productivity, improving intercompany communications and ending vicious circles of returning calls to people who've returned your calls, etc.

Systems of computers and peripherals linked together in adjacent offices and buildings, or *local area networks* (LANs), will bring about complete office automation and standardize computer interconnections. But we're not quite there, yet.

Office computers are no longer designed for the exclusive use of computer professionals; from senior management to the receptionist, employees are expected to use computers as standard parts of the office environment. Everyone from a trained analyst to a temporary secretary now needs to have access to information in databases and process it electronically.

In business, a wide spectrum of individuals must share information; rarely is true personal data encountered in corporate situations. One person might enter the basic data, another will edit or modify it, and a third will produce reports or graphic displays from it. Information is typically supplied by many sources but must be merged, managed, and distributed to be useful. Also, because information is a valuable resource, it must be protected from malicious or accidental misuse.

Traditional multiuser computer systems, whether mainframe or minicomputer, are not well suited to this new type of automated applications. Conventional systems require large centralized facilities, inaccessible to the user. They require costly support staffs. Maintenance problems make it difficult to justify new development, resulting in today's widespread applications backlog.

Conventional systems also lack the responsiveness, ease of use, and user orientation of the newer desktop systems. They are designed for a more sophisticated, trained user, thereby limiting their usefulness for the far broader class of new computer users.

This unsatisfactory state of affairs, contrasted with the benefits of friendly, fast, and economical personal computing, is spurring current desktop computer development.

The Communications Requirement

Although often separated by distance, allied users must work together cooperatively. On different floors, in different buildings, or in different states and countries, fellow workers must exchange information. For them, communications are no longer a luxury; they are essential and growing daily in importance.

Two recent developments, local area networking and personal computing, provide a way to address the needs of this new class of computer users; *community microcomputing* is the merger of these two technologies.

Community microcomputing enables a community of users to share information that resides on common peripherals. Users share common programs and data as well as expen-

About the Author

Harry Saal is the president of Nestar Systems Inc.

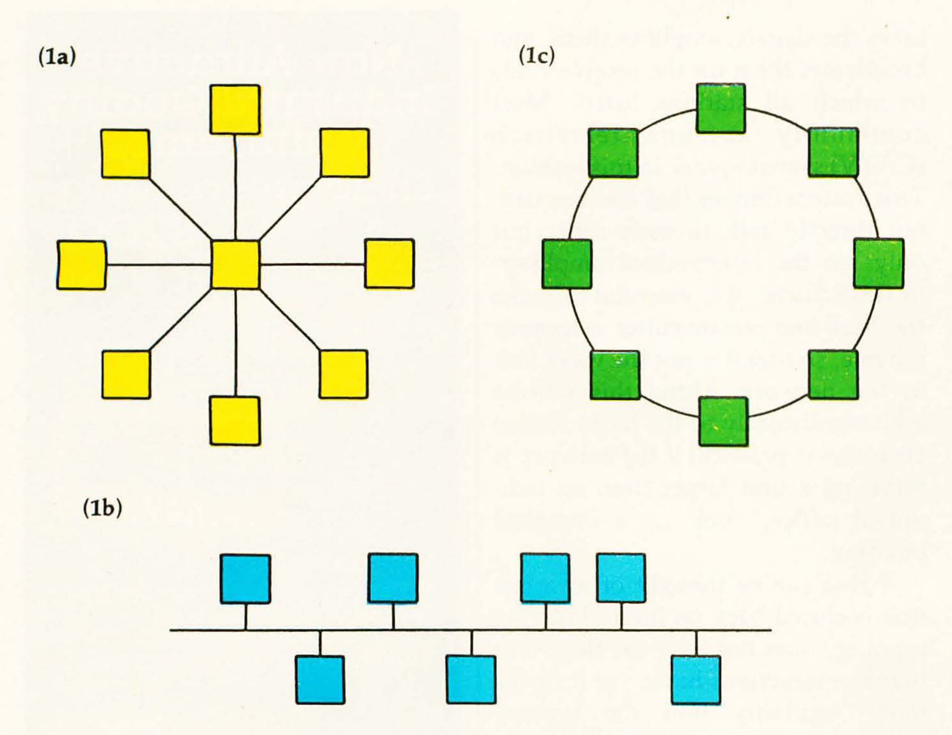


Figure 1: *Popular network configurations. The star network (1a) is the most common of the early network types (such as the telephone system) and relies on the central node for control of operations. Bus configuration (1b), as used on the Ethernet and by cable television, allows nodes to be added or removed without impairing the network. The ring network (1c) circulates all messages in one direction and may pass tokens to specify which node may transmit; a failure of any node may interrupt network operation.*

sive, high-quality equipment such as printers and disks. Individuals connected to a community microcomputing system have their own dedicated personal computers as well as support environments for communications and for sharing of peripherals and information. Familiar personal computers, serving as desktop workstations, provide a nonthreatening setting that enhances the effectiveness of professional and clerical workers. These personal workstations are open-ended, multifunction tools that make possible word processing, data manipulation, graphics, and sending electronic messages.

Attributes of a LAN

Local area networks are a specialized part of the larger class of communications networks. They undertake the job of intercomputer communications within geographically limited distances in a very reliable and cost-effective way. Conventional long-haul (telephone) lines and satellite systems are optimized for the transmission of analog or digital data over thousands of miles. Local area networks are optimized for use in the office or factory, over distances of hundreds to many thousands of feet.

Local area networks typically are bounded by speed as well as distance, running several hundred thousand bits per second to as many as tens of millions of bits per second.

Speed and distance, however, are not the only two design considerations of a local area network. LANs operate with digital data and exhibit high reliability of communications over the distances specified. A system of error detection must be added to the digital information to ensure that even a rare error will be detected. Additionally, an error-correcting mechanism is needed to ensure that the correct data is retransmitted.

To accomplish retransmission, data is split into groups or packets. Each packet contains information regarding its source and destination. Most local area network schemes permit a special form of addressing referred to as *broadcasting*, whereby a station may send a packet that is destined for all stations connected to the local area net. *Multicasting* is similar; however, in multicasting the targeted stations are a subset of the totality of connected stations.

Typically, within the data packet, there are various acknowledgments, additional information concerning the sequencing of packets, network addresses, etc. This information is used to provide more sophisticated services to the programs running on the workstations than services simply based on a "point-to-point" transmission medium. Such sophisticated services include routing, distinguishing which programs on a particular machine are addressed, and identifying character sets and protocols in use.

The error-recovery schemes used in local area networks generally make it possible to add a new station to a functioning communications network without disrupting ongoing operations. This possibility results from several factors: First, the act of connecting (or disconnecting) a new station to the actual network medium causes some momentary interference and errors. But the basic design of the network accommodates such errors automatically, by retransmitting the information. Second, because local area networks are designed as fully distributed systems, there is no central station or master list of stations that must be updated in order for the system to continue functioning. This updating of station information takes place dynamically as the system runs. In more conventional communications schemes, it is generally necessary to stop the system and take some global action in order to add or delete a network node.

Network Topologies

The form of the physical connection of stations to the communications medium generally falls into one of three main categories: star, bus, or ring form (see figure 1).

Telephone systems are the best example of the star configuration, or topology. Each instrument is connected via cable to the central office where the switching is done between

stations. To talk to your next-door neighbor, the information must flow *to a main switching* point, where it is processed by an exchange, then back to the house next door.

Few examples of the star topology used in local area networks exist, other than the private-branch-exchange (PBX) telephone system, due to the problems encountered by having a specialized piece of equipment to service all the stations at the ends of the lines. In computer systems, the services to be performed by the switch are likely to become more complex over time. This may require more than one piece of equipment, which makes it more difficult to arrange the equipment in a star configuration rather than in a bus or ring topology.

The star topology seems most suitable to a PBX-type system in which the main service requirement is data-switching from point to point. The data speed requirements are generally nominal (less than 50K bits per second), and the wiring exists in millions of offices. This type of network works efficiently when fairly powerful multiuser systems are connected to it, thus providing the computing power for low-speed intelligent terminal devices. With many of the existing telephone systems manufacturers preparing to introduce this type of network, it could well dominate in the future.

The bus topology usually involves one long central spine of cable to which each of the nodes is connected. Nodes may connect directly, or as in many cases, they may be connected via a *cluster box*, which provides for multiple station connections. By connecting several cluster boxes, you obtain a treelike structure of interconnected cables, or a "star of stars." This configuration still remains a bus in the sense that stations can still communicate directly without the need of an intermediary station.

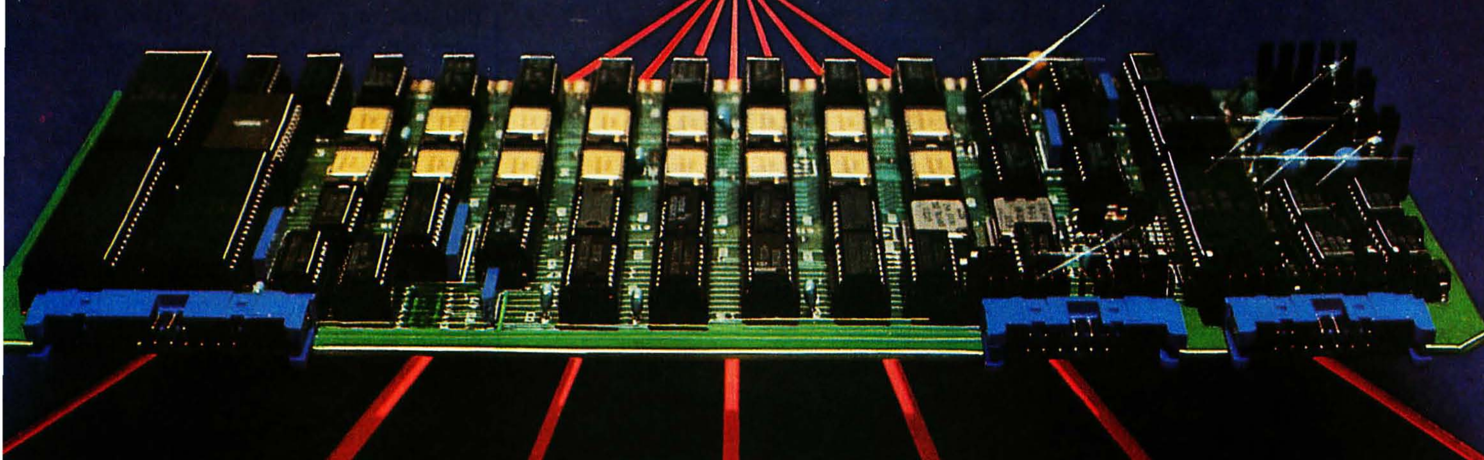
Bus schemes are sometimes found with two cables running to each station; one cable receives while the other transmits. In this case, all the transmitters are connected together via a bus that runs to a special *head-end retransmitter*. This retransmitter takes the signals, amplifies them, and broadcasts them on the receive cable to which all stations listen. Most community antenna television (CATV) systems work in this fashion. This system implies that stations cannot directly talk to each other but only via the intermediate amplifier. In this scheme, it is essential to make the head-end retransmitter extremely reliable, so that it is not the weak link in the network. Using this scheme adds significantly to the basic system cost; this is practical if the network is servicing a unit larger than an individual office, such as a complete building.

A ring can be thought of as a bus that is closed back on itself. The ring topology does not have the flexibility that bus structures have, yet it forces more regularity into the system, thereby assisting in error-diagnostic and repair capabilities. In ring systems, the information circulates (clockwise or counterclockwise), and it is possible to implement a scheme whereby a station can check to see if the data transmitted was received or not. This is done by looking at control information that is inserted or modified by the receiving station and passed around the ring, sometimes followed by a token.

One proposed ring system uses a pair of counter-rotating rings to circulate information. This system permits a nonfunctioning station to be isolated while all the other stations are still interconnected. On the other hand, adding or deleting a station from a ring system is more complex than with either the star or bus approach. The process typically disrupts the closure of the ring for significant periods of time during which the system is not operational.

Standards

The office is one of the most heterogeneous of all data-processing environments. Typically, companies have already acquired an assortment of word processors, small computer systems, and telephone exchange equipment and may be using outside timesharing services. Since one of the goals of a local area network is to facilitate the intercomputer com-



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munications within the office, it is very attractive to imagine a local area network that can connect together a variety of equipment, present and future.

The equipment must be compatible on many levels to accomplish this interconnection. Practically speaking, most vendors rely on the lack of interchangeability to prevent their customers from rushing off to the competition, and they do not actively publish specifications that enable easy substitution. Very often commonality comes about in informal ways, in which a number of vendors play follow the leader, otherwise known as being IBM-compatible! But the world of communications is one domain in which the need for information interchange requires more than casual attention to standards.

The ISO Reference Model

The International Standards Organization (ISO) established a framework for standardizing communications systems, called the Open System Interconnection (or OSI) Model. The OSI architecture defines seven layers of communications protocols, with specific functions isolated at each level. The purpose of layered protocols is severalfold: one significant advantage is that differing lower-level implementation details can be hidden, while compatibility can still be achieved at the higher levels. This permits considerable variation in the basic electrical technology, while retaining the fundamental information flow between systems.

Level 7 is the Application Level, which handles the utility aspects of network usage. Issues such as the identification of users, selection of services, or global network access are dealt with by Level 7. Typical programs at this level are file transfer programs, terminal-to-terminal emulation capabilities, and electronic message programs. At this level, tasks are performed; all the lower levels are there to support applications.

Level 6 is the Presentation Level, which handles the conversion of data

from one format to another. This involves the packing and unpacking of data, changes in character set, expansion of graphics commands, and encryption.

Level 5 is the Session Level, in which the establishment and termination of streams of data from station to station are handled. Level 5 is typically responsible for mapping network-oriented addresses into more logical process or port names on the local workstation.

Level 4 is the Transport Level, which manages a lower level of connection than the Session Level and handles the connections needed to deal with messages that exceed the maximum packet size of the network. Making a reliable end-to-end connection across an imperfect basic network is done by Level 4. Error control, sequence checking, handling of duplicate packets, flow control, and multiplexing issues are the main concerns of this level.

Level 3 is called the Network Level. It deals with the routing of information from node to node via intermediate nodes and stations. This is often not required on the local network itself due to the broadcast nature of the information exchange, or because of direct addressing provided by the network hardware. Interconnections between more than one LAN, however, require a functional Level 3.

Level 2 is referred to as the Data-Link Level. The data-link deals with the actual packets themselves and provides for the addition or removal of header and framing information surrounding the actual data contents. These headers provide for timing signals, error-detection checksums, and station addresses for hardware recognition. It is the data-link level that incorporates the access strategy for sharing the basic cable among many stations: for example, whether it is a round-robin protocol, controlled token-passing, or a probabilistic contention scheme.

Level 1 is the Physical Level, which defines the electrical and mechanical characteristics of the network. The particular signaling scheme used, modulation techniques, frequencies, and voltages employed are all specified at this level.

See table 1 for an idea of how the major microcomputer networks fit into the ISO framework.

Adoption of Standards

Clearly a need exists for some level of electrical compatibility at which a standard connector, standard signaling levels, etc., are used to successfully build fully integrated office systems that directly link together disparate office equipment. The most attention has been on the layers that deal with these issues, namely, Levels 1 and 2. This attention should result in the availability of standard components that a variety of manufacturers can use, thus reducing the cost to the consumer. This attention also follows the industry's tendency to feel that once the hardware is compatible, the software "can always be fixed later." It is interesting to note that this

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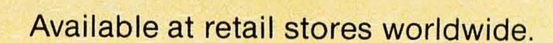
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Local Area Networks in the ISO Reference Model

Level					
7 Application	Constellation: password entry, disk back-up, and diagnostics	Constellation: password entry, disk back-up, and diagnostics	electronic mail, virtual disks, file transfer	electronic mail, print spooler, 3270 emulation	text, graphics, and print formatting; electronic mail
6 Presentation	Constellation	Constellation	PLAN 4000	3COM	Xerox Network Systems Courier
5 Session	Constellation	Constellation	PLAN 4000	3COM	Xerox Network Systems
4 Transport		Omninet	Xerox Network Systems	Xerox Network Systems	Xerox Network Systems
3 Network		Omninet	Xerox Network Systems	Xerox Network Systems	Xerox Network Systems
2 Datalink	polled (switched)	Motorola ADLC (CSMA/CA)	ARCnet	Ethernet	Ethernet
1 Physical	parallel 34-wire flat cable	RS-422A twisted-pair cable	ARCnet	Ethernet	Ethernet
Vendors	Corvus Multiplexer	Corvus Omninet	Nestar PLAN 4000	3COM Ether series	Xerox

Table 1: *Microcomputer local area networks in the levels defined by the International Standards Organization reference model. The ISO model provides only a framework not a standard. Most network systems (like Ethernet) implement only a few of the layers.*

type of standardization argument actually runs contrary to the purpose of the OSI model; the OSI model attempts to preserve compatibility across applications by permitting variation in the lower levels as long as they are fully shielded from the higher-level programs.

IEEE 802

A great deal of attention has been focused on the activities of the IEEE (Institute of Electrical and Electronics Engineers) 802 Committee. While de facto follow-the-leader-style standardization may be the dominant trend, official standards processes are important in the communications world. Hence, all the major computer manufacturers have participated actively in the IEEE standards work on local area networks.

A curious state of affairs has developed in the IEEE 802 Committee. After substantial initial activity, the Committee finally recognized the impossibility of adopting only one standard that would satisfy the variations in speed, distance, reliability, cabling, etc., required by the computer industry. Rather than to give up entirely, the current plan is to have a series of alternatives, each with several options. However, even this strange and indecisive proposal compares favorably to what is essentially anarchy in the current choice of product offerings.

The IEEE 802 standards are split into three main areas: (1) 802-3, a carrier-sense multiple-access with collision detection (CSMA/CD) system, based on the design of the Ethernet system; (2) 802-4, a token-passing bus network, and (3) 802-5, a token-passing ring network. The latter is especially interesting to industry observers since IBM is its strongest advocate in committee and public technical discussions. Each of these fundamentally different schemes has at least three or four alternatives, which vary such parameters as data rate, transmission medium, distance traversed, and modulation and encoding techniques used. For example, within the token ring scheme, there are four variations of speed (1, 4, 10, and 20 million bits per second) using two different types of cable (150-ohm twinax, or a bundle of three lines of 75-ohm coax).

It is likely that the American standards for the lowest levels will be adopted during 1983. The years of work that went into the standardization process thus far are a portent of even more complex activity needed to standardize at the higher levels of networking protocols. Some companies, like Xerox, have published the standards they have adopted for their own products, and this encourages other companies to do the same. The National Bureau of Standards has proposed a series of higher-level protocols for the transport level and electronic messaging.

For users of networked office systems, this is an unfortunate state of affairs since they are primarily interested in the Application Level. Users want to move information from system to system, have it shared between machines with different internal hardware, and be able to display graphs on a variety of screens with different qualities and features. No doubt this capability is the ultimate goal of

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standards activities for LANs, yet the prospects for resolution appear to be years away.

Office systems buyers should, therefore, not anticipate that a local area network will make it possible for their IBM Displaywriter to talk to their Wangwriter and then to their CP/M machine without the addition of special programs and services to make it possible. Similarly, the adoption of electrical standards, whether by official committee or de facto adoption, does not solve the fundamental difficulties inherent in handling a variety of computers, with different operating systems, languages, and databases. Local area networks expose these problems to the harsh light of day; they are not responsible for having caused them.

Cost and Acceptance in the Office

For a wide range of applications, community microcomputing solutions are far more economical than conventional *multiuser minicomputer* approaches. Community networks are less expensive to purchase and, due to lower overhead, less expensive to operate. Fitting easily within existing office environments, community networks are less expensive to install than dedicated computer facilities.

More than price alone separates the personal computer local area network solution from traditional computing systems. To achieve productivity gains, workers must accept a system rather than resist it. Using familiar personal computers as workstations significantly aids in that acceptance. If a LAN functions transparently, the users see the network as an extension of their own personal environment rather than as a complex distributed data-processing system in which they feel like mere "nodes." The users feel that they are controlling their environment, not being controlled by it. This feeling of control and individuality by the user is the single most important difference between traditional systems and community microcomputing systems.

This article does not attempt to completely survey the available local area network hardware and software for personal computers in office applications. Instead, I will try to give several particular illustrative examples and let the interested readers follow up directly with their local computer vendor or by study of the references.

First, let's look at some of the microcomputer vendors who have gone ahead and designed their own proprietary networks for their own machines.

Proprietary Networks

Apple Computer Inc. recently announced a network for Apple products but has not delivered actual hardware and software or complete details on it yet. Applenet is described as a 1-megabit-per-second network, connecting as many as 128 stations over at most 2000 feet. It uses a twinax cable, which runs between a series of transformer-coupled boxes that permit as many as four stations to tap in at a time to the main bus. A

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spokesperson stated that Apple expects the networking hardware to sell for less than $500 per station and be available at the end of 1983. Although the network was announced as part of the new Lisa computer, Apple stated that Applenet will also be available for the Apple II and III machines. No details were given on the kinds of hardware or software services that will be made available with Applenet.

Altos Computer Systems introduced its own Altosnet during 1982. This system can connect together as many as 32 stations at a data rate of 800K bits per second. Each system attachment costs $295. Currently, Altosnet appears to be available only for the interconnection of more than one Altos multiuser (Xenix) system to another. It cannot be used to network independent single-user personal computers at this time.

Digital Microsystems has been one of the pioneers in this field, providing the Hinet system. It connects as many as 32 users at 500K bits per second, by a maximum of 1000 feet of multiwire ribbon cable. Digital Microsystems has recently introduced a series of special workstations, specifically for use on its network, which do not incorporate local disks. This is one of the first network-only workstations available in the microcomputer world.

North Star Computers provides the Northnet system for its Advantage microcomputer. This system supports CP/M-only applications and permits the sharing of resources in a 4000-foot end-to-end network. The network runs at 1 megabit per second and costs approximately $400 per station.

Cromemco Inc. provides its own C-Net, which is a twinax-cabled system running at 500K bits per second. It costs more than $1000 per user if an interface is dedicated to each workstation but drops to less than $500 if shared among 5 or more users.

Vector Graphic developed its LINC (local interactive network communications) system, which is a token-passing network, running at 750K bits per second, over two twisted-pair cables. As many as 16 stations can be connected over a 2000-foot distance, at a cost of about $750 per station. An enhanced version of CP/M is provided for network access.

Nonproprietary Networks

Only a few networks were developed by a computer vendor and then subsequently adopted by a number of other companies for their own use. There are three prime candidate networks in this area: the Corvus Omninet, Xerox Ethernet, and Datapoint ARCnet (attached resource computer network).

The Omninet system is designed for educational and small-business markets. As many as 64 stations can be connected to a 1000-foot cable. Repeaters can be used to extend the cable length to as many as 4000 feet.

The three prime candidates for standard networks are the Corvus Omninet, Xerox Ethernet, and the Datapoint ARCnet.

Omninet transmits data at 1 megabit per second, and a variety of microcomputer interfaces is available from Corvus Systems Inc. The interfaces range in cost from about $500 to $750. Corvus has worked with several computer vendors and licensed the technical details to them for use with their own offerings. Some examples of these companies are Dictaphone, Onyx, NCR, and Texas Instruments. Corvus also offers the simpler Multiplexer that shares time on the peripherals and uses the same high-level Constellation software that Omninet does. Corvus now manufactures its own office workstation, known as the Concept, which comes with a network interface as a standard feature.

Xerox Corporation has developed and licensed its own networking system, Ethernet, with the support of Intel, Digital Equipment Corporation, and many other manufacturers. Ethernet communicates at 10 megabits per second and can connect as many as 1024 stations attached to a series of segments that span as much as 7600 feet. Each station is given a unique 48-bit address, and Xerox provides a means of coordinating addresses and protocols on a worldwide basis. The Ethernet scheme provides the technical basis for one of the three IEEE committee standards. Due to the very early availability of the technical details from Xerox, Ethernet achieved a large measure of de facto acceptance prior to any formal adoption. Xerox has also released many of the details of the higher-level protocols, the Xerox Network Systems, that it uses throughout its network products; this, too, has led to significant de facto standardization to date.

Due to Ethernet's high performance and tight technical specifications, Ethernet controllers have been more expensive than other offerings. The recent production of custom very large scale integration (VLSI) chips has lessened the disparity, and the 3COM Corporation has introduced an Ethernet controller for the IBM PC, with a price of $950 per station. The 3COM Corporation also offers a shared hard disk, Ethershare ($11,500), and software packages to use with it. Etherprint ($750) enables several users to share printers, and an electronic mail package, Ethermail ($1500), provides sophisticated office communication for as many as 1024 users. The 3COM Corporation has agreed to provide Ethernet controller cards to Apple for use in all Apple's personal computers, including the Lisa, and also supplies controllers on an original equipment manufacturer (OEM) basis to companies such as Altos Computers and Digital Equipment Corporation.

Datapoint Corporation introduced its ARCnet system for linking together its own series of office equipment products beginning in 1977. Since then the product has expanded and, due to the thousands of systems being sold, was reduced to VLSI circuitry early. These circuits are available without any licensing fees or restrictions from their manufacturers, which is a more open stance than that taken with the previous two systems. ARCnet communicates at 2.5 mega-

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bits per second, and as many as 255 stations, as far as 4 miles apart, can be connected at a time. ARCnet is a bus-oriented system, i.e., any station can communicate to any other without intervention. But the electrical connection is made (every 2000 feet) through a starlike amplifying and isolating device; thus the physical topology resembles a star or treelike form. The form of access control used is a token-passing scheme, which is a ringlike logical connection.

The issue of installed cabling may be critical in decisions about adopting a network, as was pointed out in the discussion about PBXs earlier in the article. ARCnet uses the standard IBM 3270 coaxial and connectors for its cabling scheme, thus taking advantage of the wealth of field experience and quantity of installed cable (more than 1 million offices). Rather than costing about $1000 per station, as in Ethernet, ARCnet interfaces range from $400 to $600.

ARCnet has been adopted by two other companies to date in the microcomputer arena. Tandy Corporation announced that it will provide ARCnet capability for its Model II and Model 16 products. Tandy will provide a series of shared disk systems and the necessary software for office use.

Nestar Systems provides its PLAN (Personal Local Area Network) 4000 series products, which use ARCnet for their electrical network interconnection. Nestar chose to adopt another de facto standard at the same time, namely, the Xerox Network System (XNS) protocols (Levels 3 to 5), which are used by many Ethernet implementations. This permits the eventual easy interconnection between ARCnet and Ethernet for Nestar products, as well as the use of many XNS-based software products in an ARCnet hardware base.

Nestar's PLAN 4000 system interconnects IBM PC, Apple II, and Apple III workstations. Software is provided to permit each of these machines to operate in one of several different local-operating-system environments, rather than restricting the user to one particular choice. This may be important in permitting users to select their environment based on the available application software, and not the other way around.

Nestar, like Xerox and Datapoint, provides a fairly complete set of surrounding hardware and software offerings to add to the basic networking equipment. This includes such capabilities as sharing disks, printers, a multitude of mainframe communications packages, electronic mail, etc.

Who's Missing?

The overview here is partial. Undoubtedly by the time this article is in print, there will have been significant changes in the networking industry. In particular, the offerings from IBM have not yet been unveiled. Once done, we can expect to see many companies shift swiftly in its direction.

The crucial question has to do with activities in the operating system and application software arena. Will we see true embedding of network primitives in the operating systems produced by such companies as Microsoft, Digital Research, and Softech Microsystems? (Digital Research has introduced the CP/NET system, but it has not been an outstanding success as measured by the number of networking companies that prefer to develop their own network-based CP/M support.) And which programs will take advantage of the multiuser database aspects of networks? Will the vendors of software packages trust the security and protection mechanisms of microcomputer-based local area networks? Who will sell networking systems—local computer retailers or specialty houses that work only in selected vertical markets?

Summary

Local area networking of personal computers in the office is a complex subject. The number of solutions offered are bewildering to purchasers of such systems, and it looks as if the product proliferation will continue for some time before any true coalescence occurs. Standardization is a slow process, and the real problems have yet to be addressed. At this time, users need to work closely with

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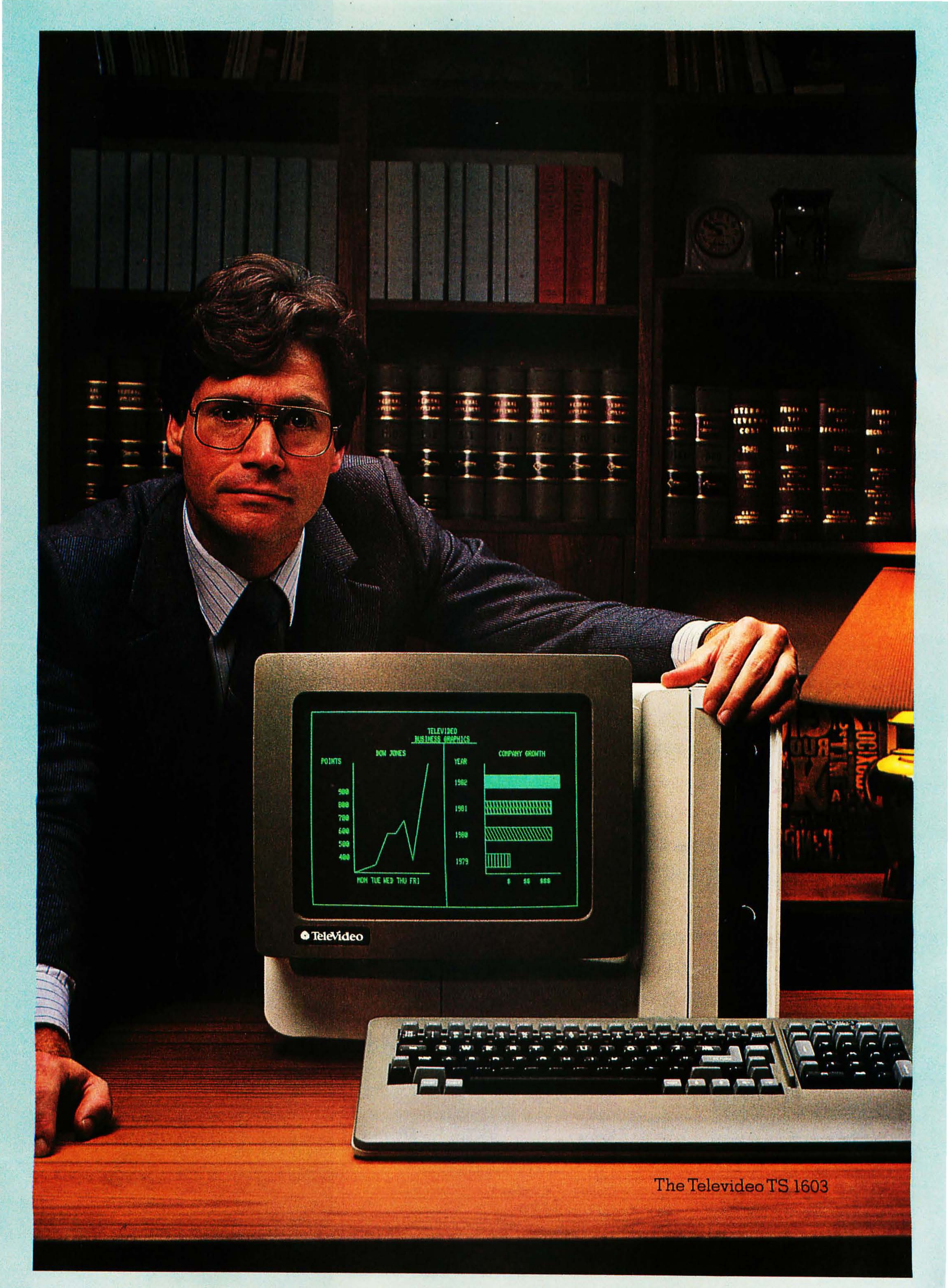
those vendors and their representatives who are well trained, knowledgeable, and dedicated to the field of networking. It is not as simple as plugging in a card, much as one would plug in a printer interface or memory expansion board. In spite of the complexity, personal computer local area networks are being used for some truly exciting applications, but, for the moment, they are not available as off-the-shelf products. Community microcomputing, the merger of personal computers and local area networking, is becoming a standard offering of most microcomputer vendors, but only a few have recognized the advantages of adopting standards and have avoided the pitfalls of the invent-your-own approach. True office local area networking is still a dream to be fulfilled. ■

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5. Wolfberg, N.E., ed. *The Ethernet Handbook*. San Francisco: Shotwell and Associates, 1982.

Vendor	Product
Action Computer Enterprises Inc. 55 West Del Mar Blvd. Pasadena, CA 91105 (213) 793-2440	*DPC/NET*
Apple Computer Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	*Applenet*
Altos Computer Systems 2360 Bering Dr. San Jose, CA 95131 (408) 946-6700	*Altosnet*
Corvus Systems Inc. 2029 O'Toole Ave. San Jose, CA 95131 (408) 946-7700	*Omninet, Multiplexer*
Cromemco Inc. 280 Bernardo Ave. Mountain View, CA 94040 (415) 964-7400	*C-Net*
Datapoint Corporation 9725 Datapoint Dr. San Antonio, TX 78284 (512) 699-7151	*ARCnet*
Digital Microsystems 1840 Embarcadero Oakland, CA 94606 (415) 532-3686	*Hinet*
EXO Corporation 1265 Montecito Ave. Mountain View, CA 94043 (415) 969-8624	*EXO/NET*
Nestar Systems Inc. 2585 East Bayshore Rd. Palo Alto, CA 94303 (415) 493-2223	*PLAN 4000*
North Star Computers Inc. 14440 Catalina St. San Leandro, CA 94577 (415) 375-8500	*Northnet*
Tandy Corporation 1800 One Tandy Center Fort Worth, TX 76102 (817) 390-3300	*ARCnet*
3COM Corporation 1390 Shorebird Way Mountain View, CA 94043 (415) 961-9602	*Etherseries*
Tri-Data 505 East Middlefield Rd. Mountain View, CA 94043 (415) 969-3700	*NNET*
Vector Graphic Inc. 500 North Ventu Park Rd. Thousand Oaks, CA 91320 (805) 499-5831	*LINC*
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The Fortune 32:16 Business Computer

A multiuser, multitasking system that runs enhanced Unix.

Steven H. Barry
Systems Research Laboratories Inc.
6231 Leesburg Pike, Suite 300
Falls Church, VA 22044

The Fortune 32:16 has garnered its share of publicity as the first well-integrated Unix-based computing system for about $5000. "Under $10,000" might be more accurate, but at any rate the system has several unique and interesting features. User-friendly, the Fortune is directed at the first-time business computer user. In this review I'll describe the system's features, cost, performance, and product support and take a look at the For:Word word-processing program.

An Overview

The basic Fortune 32:16 is housed in three cabinets—the processor unit, the keyboard, and the video display unit (see photo 1). The processor unit contains a Motorola 68000 microprocessor that runs at 6 MHz, 256K bytes of memory (expandable to 1 megabyte of main memory), and a video-display controller board. The system can presently support a four-port serial-terminal controller and a microprocessor-based intelligent-terminal controller. In the future it will support these peripheral controllers as well: an optional storage-module disk interface, a parallel device interface, a high-resolution graphics board, and an Ethernet local-area network board. A console keyboard and video interface are standard, as is an RS-232C serial interface, which is often used for a serial printer.

The unit also contains a programmable-array logic IC (integrated circuit) and PROM (programmable read-only memory) used for loading the operating system, software-security and operating-system parameter tables (parts of which can be modified by the user), and magnetic-disk storage controllers and drives.

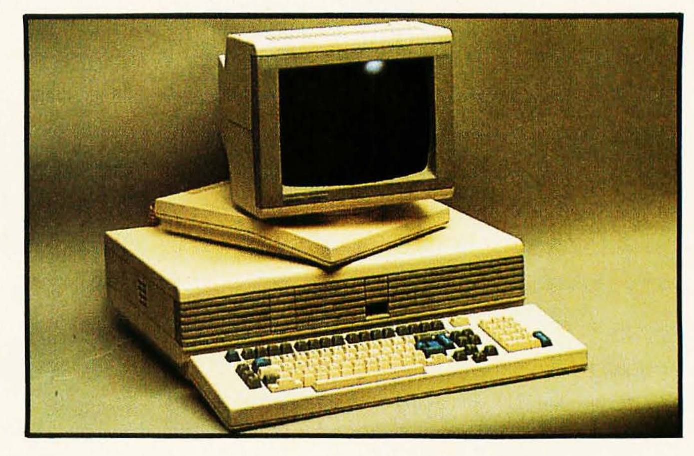
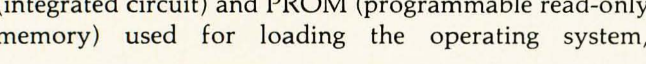


Photo 1: *Fortune's 32:16 computer system. The processor unit and keyboard and video display for a single user are shown.*

The detachable console keyboard is connected to the front of the processor unit by a 4-foot coiled cord with a modular jack. The keyboard is a close cousin of the one found on Wang Laboratories' word-processing systems, but it has a total of 99 keys, including a 15-key numeric keypad. These are well arranged and color-coded. A Help key provides access to online help pages at nearly any stage of operation. Sixteen programmable function keys, which are used by Fortune-supplied application programs, are available for user-developed programs. The keyboard provides adjustable auditory feedback, good tactile feedback, and two speeds of automatic repeat when a key is held down.



About the Author
Dr. Barry is a senior scientist with Systems Research Laboratories Inc. working on state-of-the-art personal workstations.

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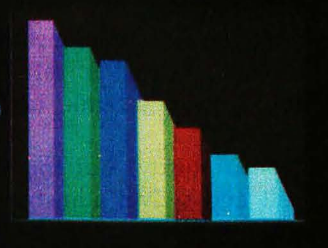
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At a Glance

Name
Fortune 32:16 computer system

Manufacturer
Fortune Systems Corporation
300 Harbor Blvd.
Belmont, CA 94002
(415) 593-9000

Price (suggested retail)
Single floppy-disk-based, single-user system: $4995
Dual floppy-disk-based, single-user system: $5990
5-megabyte hard disk, one floppy disk, single-user system: $8990
10-megabyte hard disk, one floppy disk, single-user system: $9990
20-megabyte hard disk, one floppy disk, single-user system: $10,990

Dimensions
Processor unit: 5.8 by 13.9 by 22.3 inches, 30 pounds
Console video display: 12.9 by 13.7 by 12.3 inches, 12 pounds, connected to rear of the processor unit with a 4-foot coiled cord with a modular jack.
Keyboard: 2.2 by 6.3 by 22.3 inches, 6 pounds, connected to the front of the system unit by a 4-foot coiled cord with modular jack.

Description
Fortune 32:16 computer: Motorola 68000 microprocessor, 6-MHz system clock. Minimum 256K bytes of memory, 1.0-megabyte maximum. Five memory slots (one for error checking and correction board), five I/O option slots. Standard interfaces: disk control, video terminal control board, serial line printer RS-232C, and console keyboard and display. 99-key, detached, color-coded, business-style keyboard with numeric keypad, 16 function keys, Help and Cancel/Delete keys. 12-inch green-phosphor display with 80-column by 24-row display format, 9-by 20-dot-matrix character cell, with tilt and swivel mount.

Disk Storage
One or two disk options housed within the system unit. Hard disks: 5-, 10-, or 20-megabyte stepper-motor head positioner drives (approx. 75 ms. average access time). Floppy disks: 800K-byte capacity, 96 tracks per inch, double sided. Additional disk storage in expansion cabinet: $750* (holds up to two devices). Additional 5-megabyte disk: $1995. Additional 10-megabyte disk: $2995. Additional 20-megabyte disk: $3995.

Magnetic Tape Cartridge
20-megabyte cartridge-tape drive with integral controller in expansion cabinet: $3550*. May be ordered with a disk drive (see above for prices).

Operating System
Unix, version 7 with Fortune, University of California, Berkeley, and a small number of System III enhancements. Multiuser capabilities are available for $495. The Fortune-developed user interface (i.e., shell) as well as the Unix pseudostandard Bourne shell are available to the user. Standard Unix file-system structure allows essentially unlimited nesting of user directories. Fortune has implemented file, page, and record locking features. File system and software integrity checking is executed at start-up and shut-down.

Software
Business-accounting software available. Order processing and inventory control: $595*. Accounts receivable: $595. Purchase orders: $395. Accounts payable: $595. Payroll: $595. General ledger: $395. For:word: $495. For:word Plus: $795*. Idol database-management system: $595*. Multiplan spreadsheet: $295. Business BASIC: $295. C language, FORTRAN-77, and Pascal*: $495 each. Two types of COBOL—Type 1: $495 runtime environment, $795 compiler. Type 2: unpriced at this time. Fortune operating system development tools: $495.

* Denotes items that are near release or planned for release at this writing.

The separate 12-inch (diagonal measure) video monitor has a green-phosphor screen with medium persistence and displays 80 columns by 24 rows. Characters are formed in a 9 by 20 pixel (picture element) cell. A set of up to 288 different characters can be displayed, including a subset of the AT&T videotex character set. The display's several video attributes include blink, inverse video, and bright fields.

The monitor is mounted on a sturdy, but too low, pedestal that permits easy tilt and swivel adjustments. The video display is connected to the rear of the processor unit by a 4-foot coiled cord and a modular jack.

The Fortune 32:16 comes with three hard-disk storage options: the disk controller can handle up to four 5-, 10-, or 20-megabyte disk drives. All hard-disk configurations come with a single 5¼-inch double-sided double-density 96-track-per-inch (800K-byte) floppy-disk drive. The floppy-disk drive is used for backup and for removable storage of data and programs. All software releases are on floppy disks. The processor's cabinet can accommodate only two such mass-storage devices. An optional disk cabinet will be available to house additional hard- or floppy-disk drives or a 20-megabyte cartridge-tape unit.

Depending on the user's needs, the system software, languages, and application programs may consume between 3.0 and 6.2 megabytes of disk storage. Thus a business with multiple users would be wise not to consider a system with less than 10 megabytes of hard-disk storage. Memory is also an important resource in Unix systems; it makes good sense to provide plenty of RAM (random-access read/write memory) to avoid excessive swapping to the disk.

Cost

A practical small multiuser configuration would be what Fortune Systems Corp. calls a System 10 (it has a 10-megabyte hard disk with the system keyboard and video monitor, one 800K-byte floppy disk, and 512K bytes of memory) and a four-port serial communications interface. Together with the multiuser-system software upgrade, this configuration will cost $11,980—that's without terminals or application software. The lowest-cost hard-disk-based single-user system is $7990 (a promotional price, $1795 less than list price), including the system keyboard and display, a 5-megabyte hard disk, the For:Word word-processing package (soon to be



Photo 2: *Editing sample text with For:Word. Note the status line at the top of the screen; it shows what page is being worked on, where the cursor is positioned, and where the tabs are.*

dubbed Fortune:Word, to avoid legal hassles with another company), and a certificate for the advanced (but as yet unavailable) For:Word Plus. Programming languages, programmers' "tools," screen-oriented editors, communications software, and application programs such as accounting and graphics are all available for extra cost (see "At a Glance"). Single-user floppy-disk-based minimum systems have been announced at $4995 and $5990 for one or two floppy-disk drives, respectively, but neither system is presently available. I have not used a floppy-disk-based Fortune system, so I won't comment on its utility and performance. But I will note that "standard" Unix uses both disk and memory aggressively. Based on my experience with other Unix systems and with several popular but less sophisticated and flexible floppy-disk-based CP/M systems, I am pessimistic about the performance of a floppy-disk-based Unix system.

Fortune Word Processing

One of the Fortune 32:16's most attractive features is the application software now available or planned for the near future. Word processing in particular is often cited as important for a small-computer user. The For:Word package is a close copy of the excellent Wang Laboratories system. Where differences can be found, they are either enhancements, trivial, or due to a bug. The Wang system is nearly bug-free (we have one in our office, and it was a major factor in our choice of the Fortune 32:16). The Fortune program is not bug-ridden, but it is recognizably new.

In general, the Fortune word processor compares favorably with popular alternatives for personal computers. The extensive use of labeled function keys makes learning and using the system far easier than other popular programs such as Wordstar. For:Word, like Wang's editing system, is an early approach to a what-you-see-is-what-you-get word processor.

Wordstar does a better job with word wrap, pagination, and line-by-line justification on the screen, but For:Word's printer justification is better. For:Word also does a much better job with printing, hyphenation, formatting, searches, tabulation, and advanced features. Extensive use of screen attributes makes bold print and underlines quite clear. For:Word doesn't handle superscripts and subscripts as well; the material to be half-line shifted is surrounded with vertical arrows. That's much better than Wordstar, but it doesn't make things as nice as a true what-you-see-is-what-you-get system such as the Xerox 8010 Star word processor or Apple's Lisa.

Printing on the For:Word is accomplished by a post-processor that takes, in our application, from 10 to 40 seconds, depending on file length and system loading to execute before printing begins. On the Wang system, printing starts almost instantaneously.

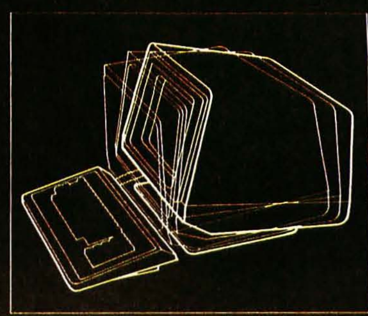
While the word processor is generally excellent, a few areas need improvement. These include line-by-line justification on the screen at text-entry time, printer-code conversion at text-entry time (to avoid long printer waits), word wrap keyed to a hard hyphen (currently done only at word breaks), the ability to start pagination or hyphenation passes at any arbitrary point in the text, and continuation of format settings (e.g., the Indent feature that keeps a block of text indented until the first hard carriage return is encountered) across page boundaries. Some of these features, such as line-by-line justification, would not look exactly like what you see on the printed page because the Fortune (and Wang) screens are character-oriented rather than bit-mapped (bit-mapped screens can be used to show microspacing on the screen). Some of these features and several others are slated for the For:Word Plus package, which is due out by the second quarter of 1983.

The word-processing screen (see photo 2) is headed by a status line that tells you the document name, the current page, line, and column, and the cursor mode. The cursor mode is the amount of material through which the cursor will move with a press of the left or right cursor-motion keys. There are five cursor-motion modes: word, line, sentence, paragraph, and page. Below the status line is the format line, which is used to control vertical line spacing (no space, quarter spacing, half spacing, single spacing, a space and a half, double spacing, and triple spacing are available). The format page also controls tab stops and line length and provides a visual indication of cursor position on a line. The text area is bounded at its bottom by a double dashed line and the words Document End.

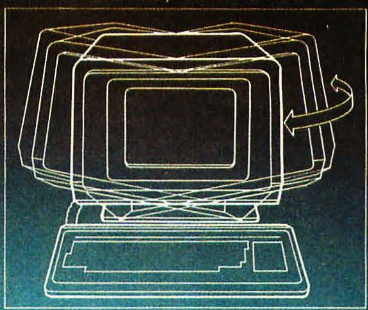
Overall document format standards are set in what is called a *prototype document*. Default settings such as line length, tabs, line spacing, and page length as well as

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FEATURE COMPARISON CHART

FEATURE	VISUAL 50/55	Hazeltine Esprit	ADDS Viewpoint	Lear Siegler ADM-5	TeleVideo® 910
Tilt and Swivel	YES	NO	NO	NO	NO
Detached Keyboard	YES	NO	YES	NO	NO
N-Key Rollover	YES	NO	YES	NO	NO
Audible Key Click	YES	YES	NO	NO	NO
Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Block Mode	YES	YES	NO	NO	YES
Insert/Delete Line	YES	YES	NO	NO	YES
Bi-Directional Aux Port	YES	YES	NO	YES	NO
Columnar Tabbing	YES	YES	NO	NO	YES
Independent RCV/TX Rates	YES	NO	NO	NO	NO
Answerback User Programmable	YES	NO	NO	OPT.	NO

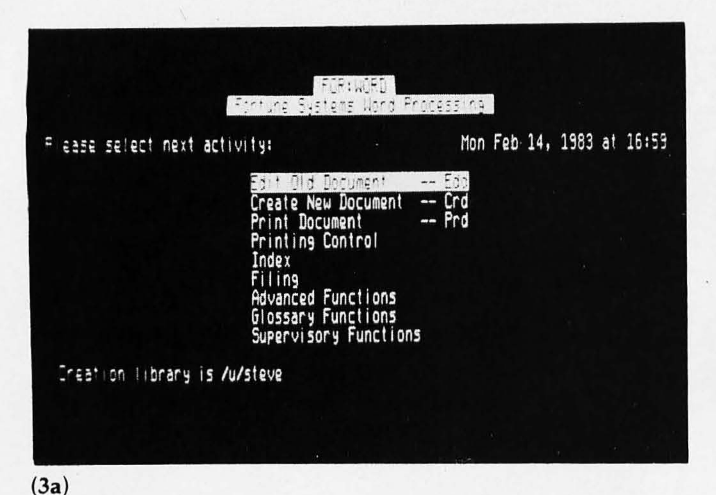
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VISUAL

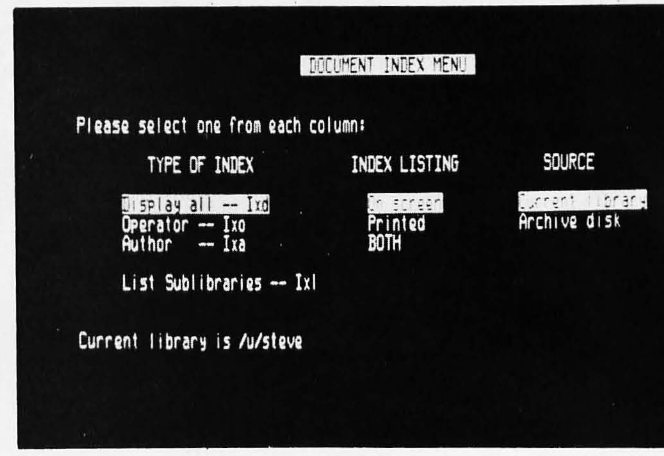
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(3a)



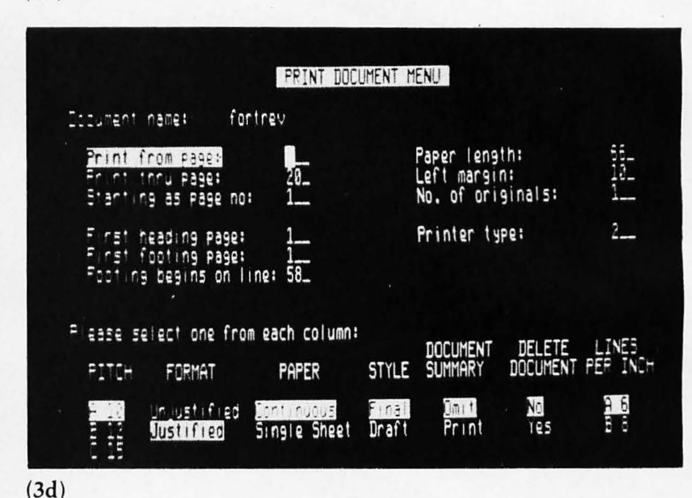
(3b)

DOCUMENT SUMMARY
Document name: fortrev
Document title: Fortune Sys Review
Operator: shb
Author: shb
Comments:
STATISTICS

OPERATION	DATE	TIME	WORKTIME	KEYSTROKES
Created	12/26/82	13:34:01	1:47:10	8316
Last Revised	1/31/83	15:30:30	0:01:08	74
Last Printed	2/14/83	14:41:06		
Last Archived	1/31/83	16:19:36	to disk /u/steve/AR000116	
Last Retrieved	2/04/83	12:01:20		

	PAGES	LINES	CHARS	WORKTIME	KEYSTROKES
Total	20	654	36510	19:20:10	73645

(3c)



(3d)

Photo 3: *Some of the menus found in the Fortune's word-processing system. The menus are the main word-processing menu (3a), the document index menu (3b), the document summary (3c), and the document printing menu (3d).*

default print options are set in this document. Each subsequent use of For:Word is initialized with these default settings.

Text entry begins at line one on a page and continues for as many lines as you want to enter. Pagination is done either manually or in a pagination pass at the end of the text-entry process. (It makes sense to define pages manually as you go along because several functions, such as Insert and Delete, trigger a line-by-line text-rearrangement process that works on a page at a time. "Pages" that are hundreds of lines long take a long time to rearrange.) A Go to Page function makes access to any selected page easy. Each page of the final output has a place for a header and a footer, which are specified by separate pages in the prototype document. Prototype documents offer considerably more format capability than is available with Wordstar.

Human-factors engineering was less a consideration when Wang created its word processor. As a result, some aspects of the generally good user interface are annoying or awkward. For:Word has improved on Wang by making processes and manipulations more explicit (see photo 3), but in some areas the user can still be easily confused. One such area is in the exit process after editing is complete. To exit the word processor text-entry mode, you press the Cancel/Delete key. An "End of Edit?" message appears at the right side of the status line. Pressing the Execute key confirms that editing is done. After pressing Execute, the following menu appears:

END OF EDIT

Cancel	erases the changes
Execute	saves the changes
Return	goes back to the editing screen

The correct choice looks easy, but in practice many users find the Cancel, Execute, Execute sequence, at first, counterintuitive. You only have to enter Cancel, Execute, Cancel once to appreciate the awkwardness of the whole process. There is no way to retrieve the buffer after such errors.

The HASCI (Human Applications Standard Computer Interface) keyboard, developed for and implemented on the Epson QX-10 computer, solves this problem by providing a Save key. The prerelease example of For:Word Plus that I saw improves on the current state of affairs

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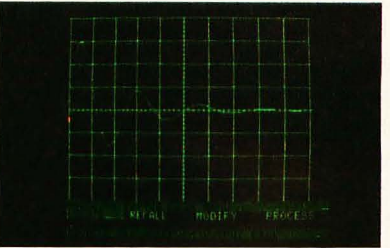
First, Northwest Instrument Systems introduced the Model 85 aScope™. Now it's joined by the aSource™ Arbitrary Waveform Generator and the aGen™ Programmable Function Generator. Result? The world's first personal computer-based, closed-loop waveform stimulus/acquisition system. A system designed for user-interaction. With easy-to-learn menu-driven set-ups. Single keystroke standard commands. And the ability to address customized applications via co-resident programs.

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ically or constructing them from previously stored waveform segments. aSource generated waveforms have 12-bit resolution and record lengths up to 4096.

aGEN

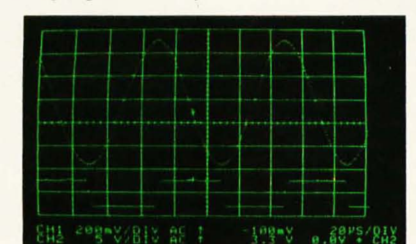
The aGen transforms the Apple II or IIe into a fully programmable 0.5Hz to 5MHz function generator that can generate all classic waveforms—sine, square, triangle, ramp and pulse.



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aSCOPE

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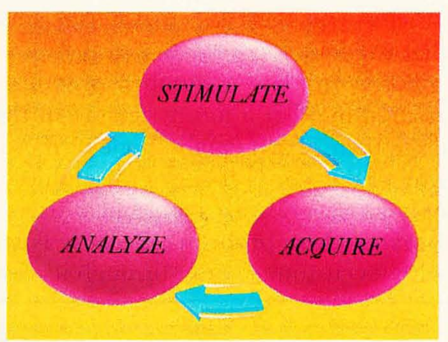


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and some other things as well.

Placement of certain options on menu screens is another source of confusion. To access document directories, you select Index on the main For:Word menu. But documents are placed in and retrieved from archives and libraries by selecting Filing on the main menu. Thus to retrieve a document from an archive you must look it up using Index, use the Cancel key twice to return to the main menu, and enter two levels of menu before you can use the name you remember from Index in order to retrieve the file. Providing an index function within the Filing menu choice would be a simple matter.

In summary, the For:Word word-processing package is a professional system that both secretarial and managerial personnel can use. The system is easy to learn, designed with users in mind, and very flexible. While the package is not complicated, its flexibility is a drawback in certain situations, as is the lack of advanced person-computer design features. Because For:Word emulates the Wang system, the most widely used word processor in the U.S., these criticisms actually apply to that as well.

For:Word has a number of bugs, and Fortune has assured me that a future version of the software will address them. Fortunately, none of these bugs stands in the way of the word processor's usefulness. Until the bugs are out, however, a list would help users to circumvent the worst of these problems. Because Fortune communicates with its customers only through its dealers, the company misses useful feedback from the field and users miss many of the company's tips and cautions.

Applications Software

Other software, available now or in the near future, includes a complete Business Accounting System with related applications such as order processing and inventory control along with a coordinated business graphics package, Multiplan spreadsheet software, Pascal, FORTRAN-77, two types of COBOL (one of which is a high-intermediate level), programmers' tools, Idol database-management software, Sequitur database-management software (third-party software known to work on the machine, but unsupported and without the company's blessing), general-purpose graphics, a very extended BASIC, a set of filters said to convert code written in other BASICs to the Fortune language (these include Applesoft, MBASIC, CBASIC, and TRS-80 BASIC), the C programming language, and the For:Word Plus advanced word processor.

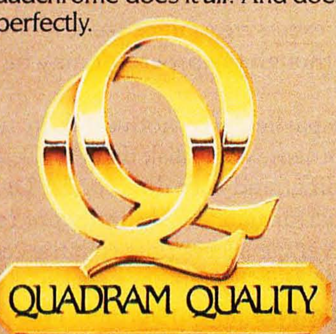
The Fortune 32:16's operating system itself is scheduled for an update around mid-year for all users. Selected users have access to an interim upgrade of the operating system. The new version, in combination with replacing some ICs on the disk controller board and the upgrade to For:Word Plus, will make the system much quicker, I'm told. Our dealer will make each of these improvements at no additional cost. The disk-controller upgrade, on the other hand, is being done for all Fortune users. Fortune



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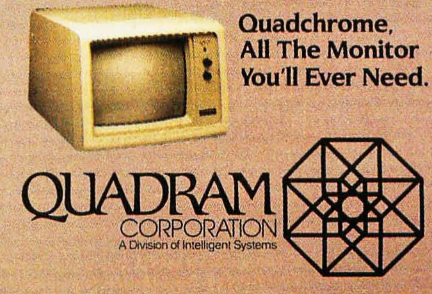
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has recommended that the dealers upgrade the operating system for only those customers who "need" it now. I suspect this policy will return to haunt both the dealers and Fortune, if only in the short run. Supporting one version of mass-distributed software is difficult enough, but it will be a nightmare to support two versions until the second and universal release is made.

Fortune would do well to consider providing a software-maintenance service that automatically updates subscribers' software twice a year, supplies revisions to manuals (and any new manuals that are published for the customers' licensed software), and offers hints and tips to the users. Digital Equipment Corporation has done just that very successfully, after a slow and awkwardly administered start. Such a service would keep all users at the same revision level, reduce bugs in the field, keep the customers happy, and enhance the company's image.

Performance

If you're accustomed to 64K-byte dual-floppy-disk-based CP/M (or similar) systems, you'll be appalled at the amount of disk and memory resources Unix systems use. Note, however, that combined program and data memory sizes totaling as much as 880K bytes may be selected on the Fortune system. The user environment, whether it's within the excellent Fortune-supplied menu-driven shell or within the more standard Bourne shell, is much more flexible than CP/M's command processor, and the operating system services are light-years ahead of CP/M's. I will describe some of these advantages in detail below. It's important to keep in mind that the Fortune has a multiuser, multitasking operating system; each user (up to a practical maximum of 12) can run multiple processes simultaneously.

A system on the order of the 64K-byte one described above is the practical minimum for multiuser business applications. In addition to the components described, the system must have terminals and a printer. We use three Fortune Intelligent Workstations along with an NEC (Nippon Electric Company) 7725 letter-quality (55 characters per second) printer. That leaves one serial port available on this configuration for telephone or modem access. Our system is used for two widely disparate types of work; our analysts spend most of their time using For:Word, while the programmers spend most of their time editing, compiling, and testing programs written in one of several languages.

Under most circumstances, the system performs at an acceptable level. Things tend to slow down quite a bit when several users are in For:Word (a lot of "character banging" goes on in this program; for each character typed, about 20 are sent from the computer to the terminal) or when they try to access the disk at the same time or during the execution of a program compilation. System response should improve when a four-port, microprocessor-controlled serial interface replaces the "dumb" unit we are now using. Another 256K bytes of memory should also make things better. Fortune notes that the universal release of an operating-system upgrade (version 2.0) at mid-year will also improve performance.

A word about response degradation is in order. All disk-based multitasking timesharing systems have the same weakness: the average access time for a disk is thousands of times slower than it is for semiconductor memory. Small-business systems usually have relatively limited amounts of memory, compared to the amount that current system and users' tasks and data require.

System tasks called daemons (British for demons) are called from the disk and executed periodically to do housekeeping chores. The process of moving inactive tasks to the disk or making room in memory for large tasks whose turn it is to run is called *swapping*. The disk is used to minimize the amount of semiconductor memory the system requires and achieves an acceptable compromise between service and cost. The swapping overhead of a system, if excessive, can cause response to become very slow, even though the processor may be idle most of the time.

Generally, delays are particularly noticeable in timesharing systems when the same hard-disk drive is used for systems software, swapping, and user directories. Delays are aggravated by low-performance disk hardware (such as floppy disks, whose average access time is in the 250 to 500 milliseconds range) and by stepper-motor head-positioners on hard-disk drives (about 75 ms). There is a consensus in the Unix community about the performance improvements to be gained from high-speed disks (about 35 ms average access time), optimal placement of direc-

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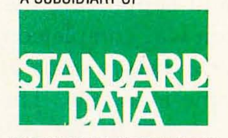
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MEMORY:						
Minimum:	128K	16K	64K	128K	128K	128K
Maximum:	768K	576K	256K	640K	512K	256K
DISC-LESS OPERATION	Yes	No	No	No	No	No
NETWORK READY	Yes	No	No	No	No	No
FLOPPY DISK STORAGE:						
Per Diskette:	320K	320K	400K	320K	1.2 MB	140K
Maximum Internal:	640K*	640K	1.6 MB	640K	2.4 MB	140K
EXPANSION SLOTS:	Five S-100 (four available)	Five (three available)	Three	**	One	Eight
I/O PORTS:						
Parallel:	1	—	—	1	1	—
Serial:	2	—	2	2	2	1
DISPLAY:						
Pixels:	640 x 225	640 x 200 (2 colors) 320 x 200 (4 colors)	800 x 240	**	640 x 200 (Monochrome)	560 x 192 (Monochrome)
Colors:	8	4	4	Optional	Not available	16
OPERATING SYSTEMS:	CP/M-85 Z-DOS (MS-DOS)	CP/M-86 IBM-DOS (MS-DOS) UCSD P-System	CP/M-86/80 MS-DOS	CP/M MS-DOS	RS 16-DOS TRS-DOS	Apple SOS

Information current as of 7/7/82. *External disk storage available soon. **Information not available at this time.

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tories and swap tracks (a feature said to be in Fortune's operating system version 2.0) on at least two disk drives to minimize disk arm movement, the use of overlapped disk seeks, separation of systems software from user directories, and separation of high disk-load users from low disk-load users. The use of only one hard-disk drive on a timeshared system can affect response time when relatively small memory is available. This is true for all timesharing systems, especially those that, like Unix, allow users to execute multiple tasks concurrently.

Product Support

Fortune has a Software Service WATs telephone number for its dealers. Users report problems to the dealers, who attempt to fix them with their own resources or query the software hotline. Because both Unix and Fortune are new to most of the dealers handling the 32:16, they often have to resort to Fortune's dealer-support system.

Because the Fortune 32:16 computer is directed at first-time business-computer users, dealers need to know about and be able to support the application software.

Our dealer, Kramer Systems International in Silver Spring, Maryland, seems to be learning to support this product fairly quickly. The company has perceived the need to provide Unix expertise and dealer support that is more comprehensive than what many microcomputer vendors offer.

Fortune offers its dealers training courses in hardware, operating-system software, and supporting the applications software. Our installation was completed relatively early in the dealer training cycle, before some of the support that's now routine became available. The Fortune 32:16's commercial success seems to be driving the dealers toward better service and, inevitably, away from a willingness to discount. Because the system is directed at the first-time business-computer user, dealers are required to know about and support the application software.

A lot of software is available now, and more is constantly becoming available. The software and manuals I've reviewed seem to be solid, flexible, and nontrivial products. The programs are well debugged at the surface level, and as a whole my impression is that this is good first-release software. Remarkably good, in fact, for an industry that routinely uses its first customers as a final test and inspection department. The software manuals are outstanding for novices, but too superficial for people who know their way around systems and software.

An effective dealer has to invest significant training in both technical and sales staffs to support the depth and range of products to be offered. A financially solid, committed, and technically qualified dealer is a valuable facet of the overall decision to use the Fortune 32:16 in a business environment. As always, it's wise to give some serious thought to the purchase contract, installation support, and maintenance before you purchase any system. Despite a marketing focus on the first-time business-user, the Fortune has (or will have) the tools to support software development on a small scale. The thought of twelve sophisticated programmers working simultaneously on a 32:16 boggles the mind, but for environments in which word processing and packaged applications constitute 80 percent of the system's use, ample resources are available. Here, too, even if you're a Unix expert, good dealer support is highly desirable (if for no other reason than as an information conduit between you and the support people at Fortune, who will not speak to you directly).

The Unix Operating System

Unix, a multitasking operating system developed at Bell Laboratories, has been both praised and damned. Experienced users find it a superb software-development environment. Often, however, a user must navigate through a complex and branching structure to find a particular file. The Unix file structure is much like a branching tree; the top of the structure is called the *root* but is referred to as / (slash) when addressing that directory.

Like other directories, / is a file, and like all directory files it contains disk address pointers to executable binary files, binary object files (the results of the compilation process or the assembler process), data files, and other directories. The user looks at a directory listing and sees the names of these files, not the pointer value.

A typical Unix file of whatever type has an owner and a set of read/write/execute permissions for other users (naturally, nonexecutable files, such as ASCII text files, can't have an execute permission). By Unix convention, most files and all commands are styled with lowercase characters.

Unix also appears to have a perverse and pervasive unwritten rule requiring all commands be abbreviated to the point of unintelligibility. For example, to get to a file belonging to a user called "george," you use a command like this: cd /usr/george. The command cd changes your current directory to the one specified after the cd command—in this case, the directory george that is itself contained in the user directory. The first / refers to the root, where everything starts; usr refers to the directory in which all user directories are kept, the second / is merely a separator, and george is the target directory. (On the Fortune Unix system, user directories are kept in u instead of usr.)

To execute a program or command, you must first have permission. Then you only need to type the name of the pathway that leads to that program.

The file-system structure enables you to organize files by subject, project, month, or whatever is convenient. Each category name is used as a directory name. Subdivisions of the category can be used as the names for



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subdirectories if you find that useful. These features are very nice, but the result is that it takes a lot of disk-head motions to accomplish a file access and execute the program. It's also very easy to forget where things are stored if you are new to Unix, the project, or have been doing other things for a while. Moreover, this structure does not promote good housekeeping habits; because all directories and subdirectories must be empty before they may be deleted, it becomes a chore to find all of your useless files and delete them, move those you want to keep, and then delete each of the subdirectories in ascending order until you are done. Because of this tedium, users need to be cajoled into releasing unneeded disk space before the disk is completely jammed with useless files. The floppy-disk drive can be used to provide a copy of files that might be useful but are not needed for current work.

Unix enables each user to execute a number of tasks—called processes—concurrently. This can be very useful: you can start compiling a program and immediately begin editing another program module. You can run a "spooler" program in *background mode* that would immediately send to another computer, via a modem attached to another terminal port, any material placed into a specific directory—just the thing for making sure that time-critical reports generated by a team of people reach their destination as soon as possible. Simultaneous printing and editing is supported, as is printer queueing.

Programs can *pipe* results to another program waiting to receive them. Thus it is possible to use several modular service programs in various combinations to create new services. One example is the program called more. Long directory listings can easily zip right by your eyes on a terminal operating at 9600 or 19,200 bits per second. The directory listing can be piped to more, which will catch the output of the listing and display it 24 lines at a time, at your command.

Yes, it would be easy to modify ls, the directory lister, to display 24 lines at a time, but then you'd have a program that makes assumptions about the terminal on which it is working. This is completely foreign to the Unix philosophy, which encourages portability and machine independence. Unix uses a file named termcap to define the individual characteristics of numerous terminals, thus making programs like more device independent. You can also use more to provide screen buffering for many other tasks—something that a custom-modified ls couldn't do. Such applications might include looking at a long file of data produced by a program or browsing through text files. You would use the cat command to catenate a file (i.e., dump it) to the default output device (i.e., the terminal), but you would pipe the result of cat to more for screen buffering. Unix contains many programs that can be used as commands or used in combinations by piping the results of one to another.

Unix has many unique and useful features. Even an experienced user of other systems will find Unix a strange and somewhat intimidating environment at first. Many of the commands have very terse and not very descriptive

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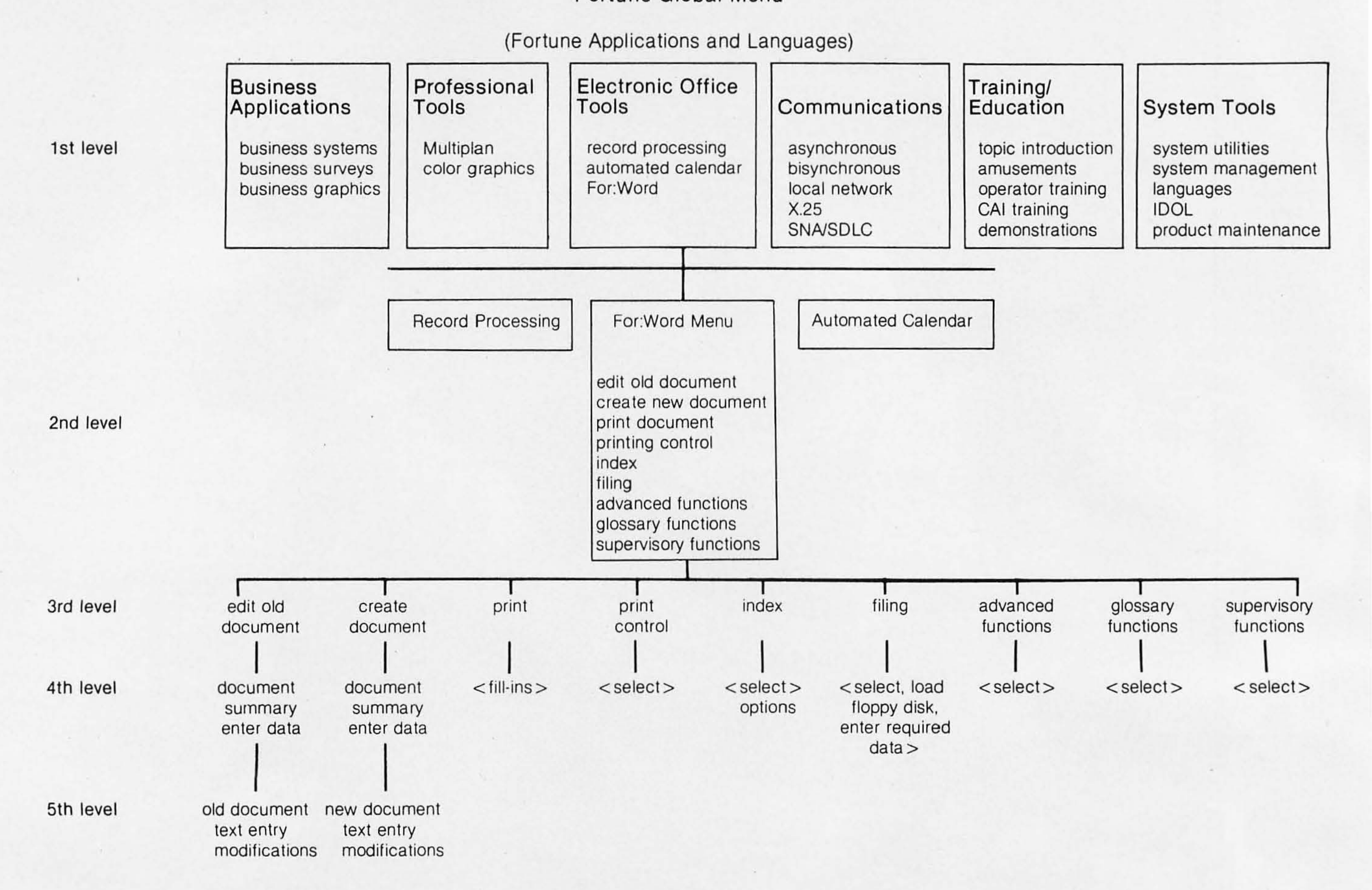


Figure 1: *The Fortune Global Menu. Each of the six applications in the first level is followed by a list of available software.*

names. For example, cp copies files, nroff is a text formatter, and cc calls the C compiler, while cb calls a C beautifier (a program that formats a C program for easy reading and good style). There is a very fussy syntax checker for the C language, called lint. The program as calls the assembler for the host machine, and df gives you statistics on the amount of free disk space available, but diff is used to compare the contents of files or directories. Literally hundreds of such commands are available in standard Unix when using the Bourne shell. These commands, together with an environment that makes group programming or other group efforts easy to organize and efficient to monitor, make Unix a very useful system for those who are willing to do the requisite apprenticeship.

Unfortunately (no pun intended), Fortune does not currently supply any Unix documentation with its system and supplies only a relatively minuscule amount of documentation with the C programming language package. I bought a set of manuals for $91 from the University of California at Berkeley, whose version of Unix is the current model for the Fortune operating system. Due to the terse and sometimes irregular syntax of commands, the large number of commands, the potential for disaster if you misuse a command (Unix assumes that you know *what* you're doing), and the industry-wide lack of Unix documentation for the casual user, many consider the standard shell inappropriate for the average business environment. Luck is on our side, however, because Unix has an answer.

Unix allows the use of many different shells. In fact, each user can have his own shell. The standard shell even lets you program within it to create new commands out of old ones. Thus there's a strong foundation on which you can build a shell that is more appropriate for an office environment. Fortune Systems is one of the companies that has done this.

The Fortune shell is menu-oriented. You sign on to the system by turning on your terminal and typing your name and password in response to screen prompts. If the name and password correspond to entries authorized on the system, you can progress to the Fortune Global Menu (or to the Bourne shell, if your account specifies this option). The Fortune Global Menu has six areas: business applications, professional tools, electronic office tools, communications, training/education, and system tools. Each of these areas has a list of available software.

Figure 1 and photo 4 show the global menu. Note that some entries are brighter than others. The brighter entries signify software options installed on the machine. To select an option, you can use the Return key, which will

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Business Systems
Business Surveys
Business Graphics

PROFESSIONAL TOOLS
P1 Multiplan
P2 Color Graphics
P3
P4
P5
P6

OFFICE AUTOMATION TOOLS
E2 Record Processing
E3 Automated Calendar
E4
E5
E6

COMMUNICATIONS
Async
BiSync
Local Network
X.25
SNA/SDLC

TRAINING AND EDUCATION
T1 Topic Introduction
T2 Amusements
T3 Operator Training
T4 C.A.I. Training
T5 Demonstrations
T6

SYSTEM TOOLS
S1 System Utilities
S2 System Management
S3 Languages
S4 IDOL
S5 Product Maintenance
S6

Fortune Systems Corporation
Press (HELP) For Assistance
Enter Selection & Press (RETURN): e1

(4a)

SYSTEM UTILITIES MENU

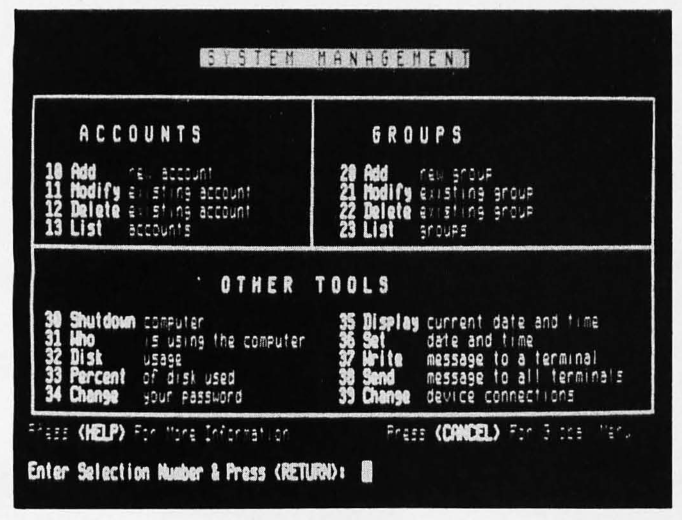
FILE HANDLING
10 Append
11 Copy
12 Create
13 Delete
14 Group
15 List
16 Move
17 Owner
18 Print
19 Permission

DIRECTORY HANDLING
20 Copy
21 Create
22 Delete
23 Go To
24 Group
25 List
26 Move
27 Name
28 Owner
29 Permission

30 Backup
31 Reload
32 Format
33 Clear

(HELP)
(CANCEL)
Enter Selection Number & Press (RETURN):

(4b)



(4c)

Photo 4: *Global system menus and submenus. The global menu (4a) is the root for all access to the Fortune's operating system; also shown are the system utilities menu (4b) and the system management menu (4c).*

move the cursor through the menu selections sequentially, use the cursor keys to select the application, or type the entry number of the desired option (e.g., e1, or E1 for For:Word), followed by pressing the Execute key.

The options within each application are also menu-oriented. Thus it is possible to get three or four menus deep into an application before you can execute a function. This procedure treats the new or infrequent user very gently, but it can be tedious for users who are familiar with their applications.

Menus are also a very slow way to use computer systems. Fortune has provided mechanisms that alleviate some of these lengthy navigations of the system menus, but these commands do not yield complete access to all options. For example, you can go to any previously created document from the Document Index display without climbing and descending a set of menus. Although it is slow and occasionally confusing, the Fortune menu shell and the menu approach to applications are generally very well thought out. Few areas have been neglected, and those are sufficiently technical in nature that the user might well use the standard Unix shell for them.

You can access the Bourne shell whenever you are being asked for a Global Menu choice by typing an exclamation point followed by the desired Unix command. The command is executed and you are returned to the menu shell at its completion.

Summary

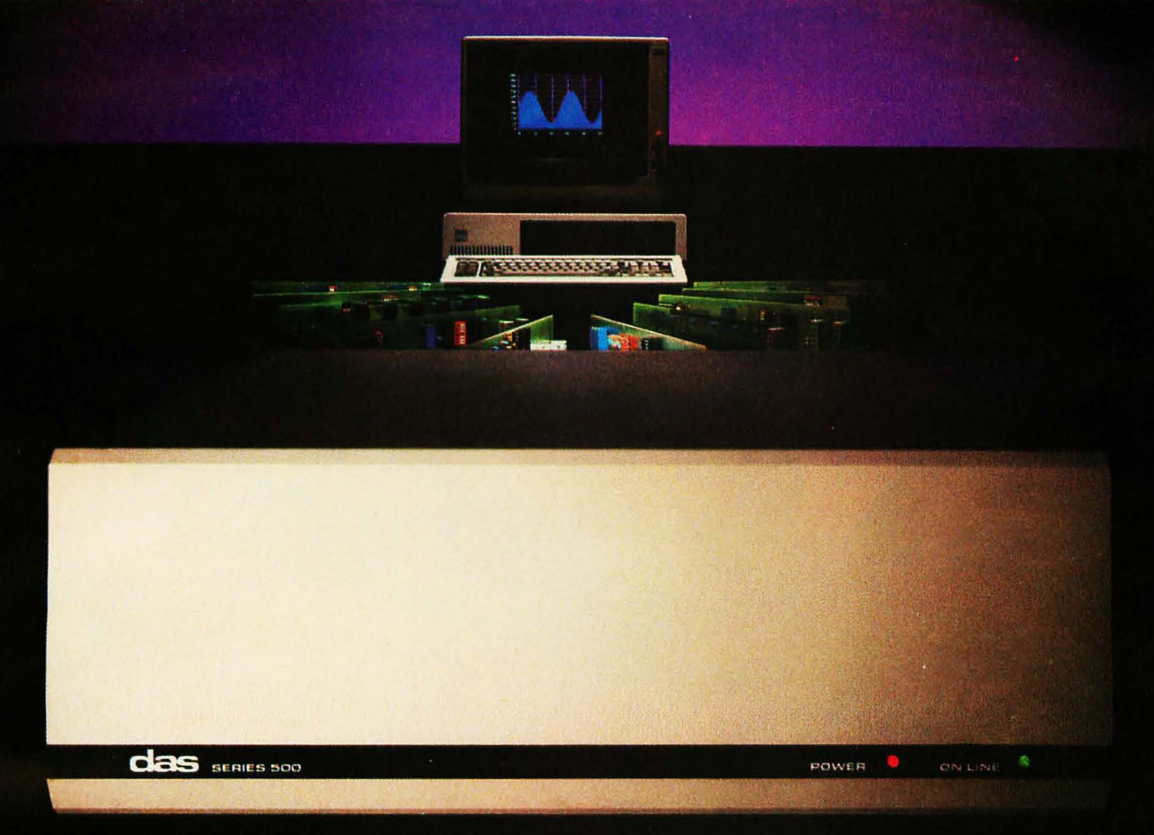
The Fortune 32:16 computer offers an oustanding business-operating environment with a reasonably good technical development environment. The system is well designed and easy to use. Dealer support is advised if you're not expert at fending for yourself in complex systems environments. The Fortune operating environment does not encourage tinkering with the inner workings of the operating system, but if you're technically inclined you'll have a good time with the system.

The major marketing consideration that distinguishes this system from the large number of similar systems on the market is its optional gentle user interface and the wide range of very high quality application software available now or planned for the near future.

Some systems are better adapted to highly technical environments, to the use of industry-standard interface cards (e.g., STD bus or Multibus), and to real-time applications. Fortune Systems has, however, created one of the better systems currently available for business use and for technical efforts that do not require all of the nitty-gritty of standard Unix, the pleasures of the Programmers' and Writers' Workbench modifications to Unix, or the flexibility of systems designed for laboratory environments. Given the technical orientation of the bulk of offerings in the Unix marketplace today, Fortune Systems has chosen the harder row to hoe and has done it very well. ■

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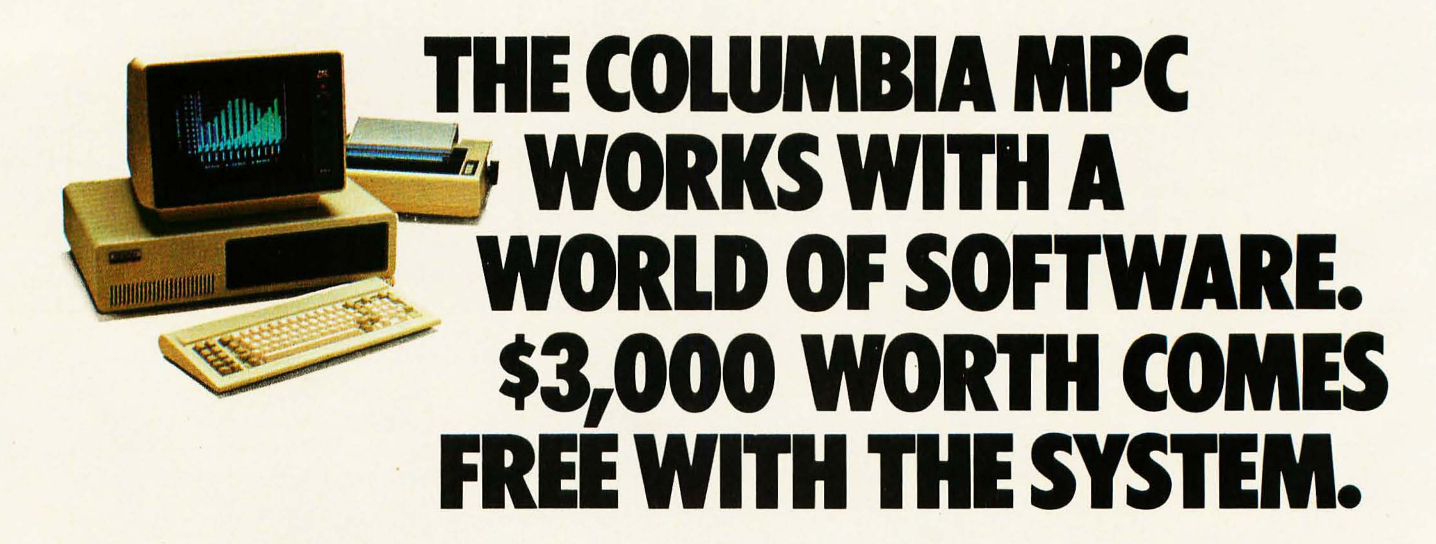
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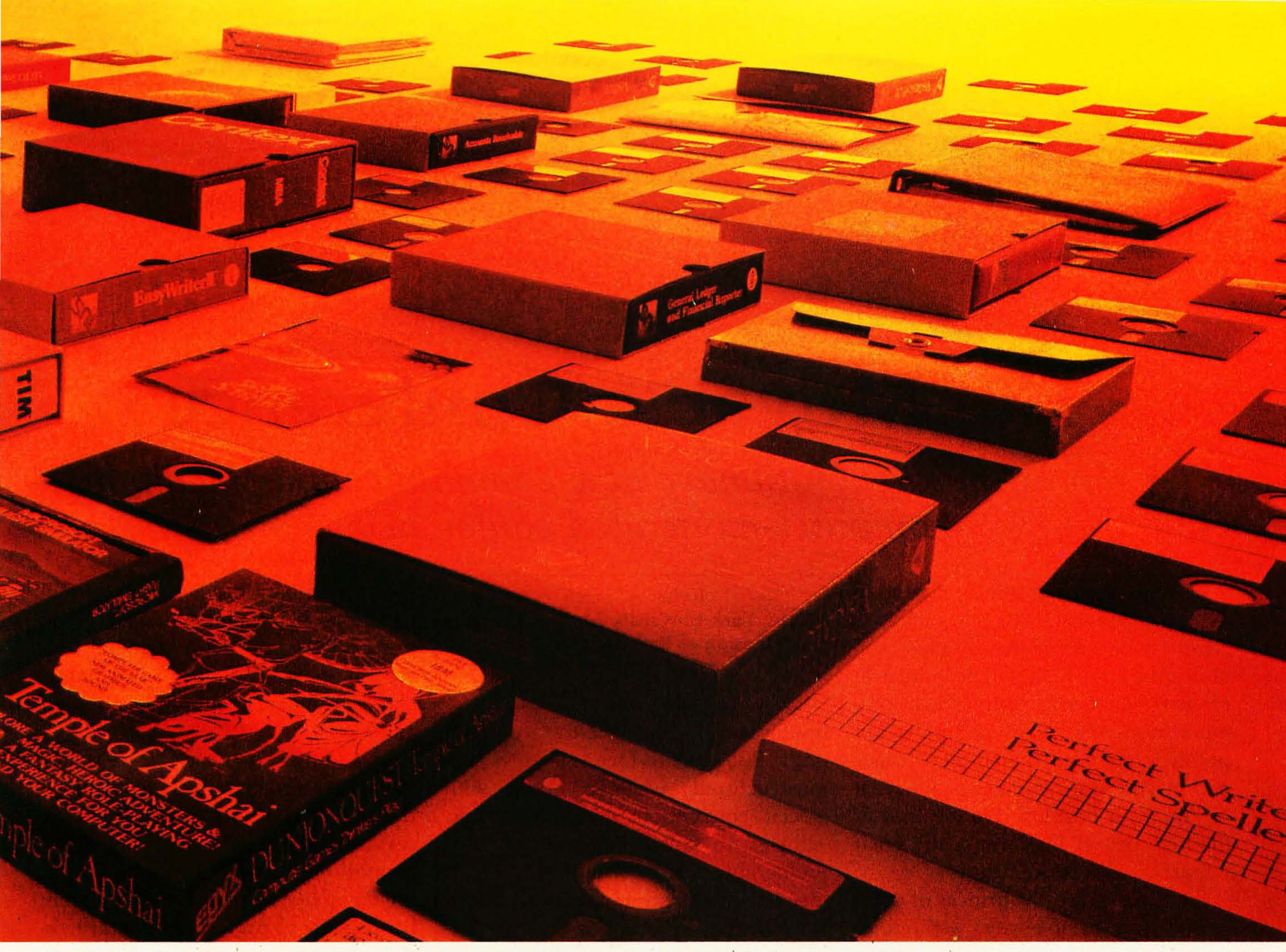
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The Movable Conference

A report on a revolutionary new communications medium: computer-moderated conferencing.

Irving A. Lerch
New York University Medical Center
Division of Radiation Oncology
566 First Ave.
New York, NY 10016

During the eighteenth Egyptian dynasty, about 3500 years ago, a royal scribe named Amenophis, son of Hapu, rose to great prominence. He was such an accomplished communicator that the pharaoh appointed him both hereditary prince and master of ceremonies of the feast of Amun, a position rivaling that of the high priests of Karnak, the great temple city of upper Egypt.

Since that time, the princes of communication have always aspired to power but have rarely achieved the deified status of Hapu's remarkable son. In 1970, however, an experiment in information science started a movement that, as this decade matures, will extend and transform this most fundamental of human activities and may confer unprecedented power on a new generation of electronic messengers.

Consider the ways we usually communicate (talking, writing, and gesturing) and how we enhance that communication (telephone, gatherings, print, video, signs, radio, etc.). Such exchanges are limited by the environment, by the need for synchrony in time and place for dialog to occur.

The most desirable form of communication is the face-to-face meeting. But face-to-face meetings are unstructured, weighed down with social conventions based on rank, subject to misunderstandings, and vulnerable to information loss. If needed data is not immediately available during the meeting, many decisions will be delayed until some time after the conclusion of the conference. Meeting planners must have exquisite foresight if everything is to run smoothly. If numerous participants are located in different cities, the travel and accommodation costs can be excessive and the meeting cut short, often before anything useful is accomplished. With the computer as communications device, however, the bonds of synchrony can be cut. A conference can now "move" in terms of both time and place to each participant of that conference.

Indeed, the most apparent difference between computer-moderated conferences and face-to-face meetings is in the temporal relationship of the exchanges. In a computer conference, messages are forwarded in time until a participant reads them and replies. Participants may review the proceedings, respond to specific messages, enter new information, ask questions of any participant, or acquire data at any time, day or night. And because each participant needs only a normal telephone line or leased communications line to connect a terminal to a central host computer, the interchange is independent of place as well as time.

In addition, because the computer maintains an accessible record of all transactions, memoranda and synopses are unnecessary; the final documentation can simply be edited from the computer memory. Add a feature for privacy to protect proprietary exchanges, and the system begins to develop a useful shape.

To a limited degree, we already have a measure of this power. The telephone enables us to contact people anywhere, at almost any time, and to carry on group conversations. We can even use the telephone to transmit printed and graphic information. But such teleconferencing must be conducted in the heat of the here and now, and the spoken word is fragile and notoriously elusive. What is obvious to one participant may be opaque to another. Some people may require more time to digest a certain piece of information. Much information is invariably lost.

Thus the conventional ways we exchange information are somewhat limited. But all of this is about to change in a way so fundamental, so profound, that the processes of collating and synthesizing information will cease to exist as separate activities divorced from communication.

About the Author

Irving A. Lerch, a professor of medical physics at the New York University School of Medicine, has published numerous articles on the impact of science and technology on society.

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Disk Doctor available for virtually all CP/M®, and CP/M-86® compatible systems.

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EMISARI

In 1970, the White House Office of Emergency Preparedness (OEP) was given the responsibility of administering President Nixon's wage-price freeze. To accomplish this difficult task, the OEP put into use the first electronic conferencing system, the Emergency Management Information System and Reference Index (EMISARI). The following quote from *The Network Nation* by Starr Roxanne Hiltz and Murray Turoff (Addison-Wesley Publishing Company, 1978) describes how EMISARI supervised information flow:

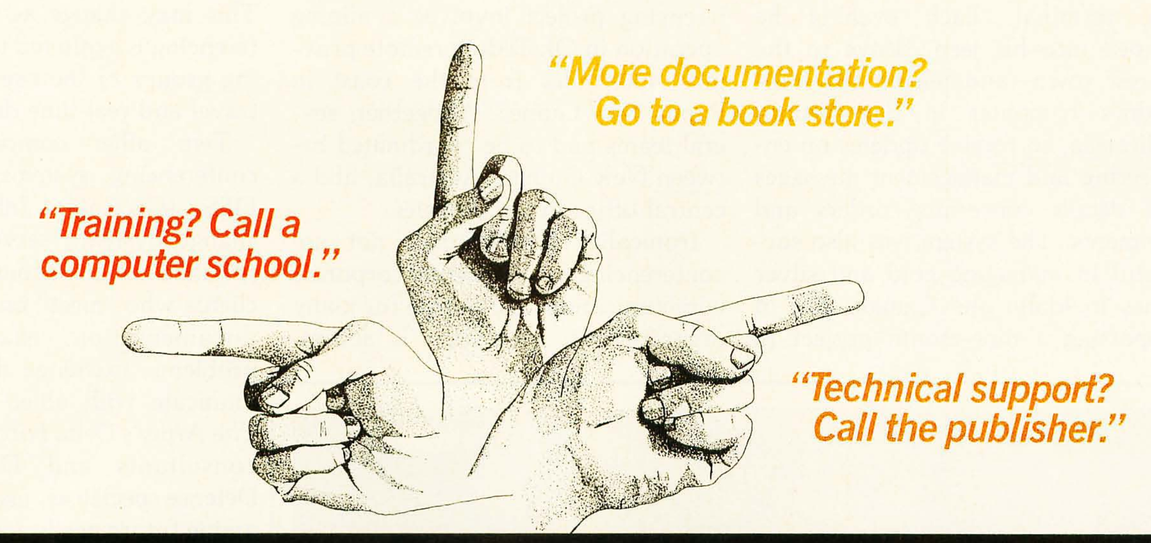
> *The ten regional offices of OEP needed to be able to generate and share timely and useful data on . . . the wage-price freeze. The regional offices had to respond to requests and inquiries from the public in a way that was consistent with the initial guidelines and emerging modifications and interpretations. The central OEP management had to make sure that policy interpretation was consistent from region to region. . . .*
>
> *The primary innovation in EMISARI was the ability to set up alternative communication forms, such as collections of numeric estimates, tables of numbers, and situation report forms, and have these assigned as a permanent responsibility to some member of the communication group who would supply the information on a regular basis. . . . All this was under the control of a human monitor who could tailor the communication structure and the responsibilities as a function of the problem at any time.*

As you might imagine, the advent of this unique, computer-moderated conferencing system was accompanied by a great deal of discord between the OEP establishment and the outsiders who invented EMISARI. The story of this conflict, recounted by Hiltz and Turoff (one of the designers of EMISARI) in their book, illustrates the friction generated when control over information changes hands. In spite of this difficulty, however, the concept of computer-moderated conferencing has been employed in a number of communications systems.

From New Guinea to the Electronic Cottage

A few years ago, the multinational Bechtel Corporation approached its telecommunications group with a problem: how could a team of employees scattered across several time zones and continents maintain effective communications? The great geographical dispersion made it clear that only a messaging service would work, yet the traditional methods were inadequate to sustain technical dialog among the 10 to 12 people in a team. Bechtel solved the problem by subscribing to Infomedia's Notepad system, developed by one of the premier innovators in the field, Jacques Vallee.

An early Bechtel project using Notepad was centered at a Nevada molybdenum mine with no telephone access. In order for the site manager



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to communicate with a central office in San Francisco, he was given a portable terminal. Each evening he jumped into his jeep, drove to the nearest town, and telephoned Infomedia's computer in San Bruno, California, to receive updates on engineering and management messages and details concerning orders and shipments. The system was also successful in managing gold and silver mines in Idaho and Canada and in supporting a nine-month project in the Beluga oil fields in Alaska.

The most spectacular Bechtel conferencing project involves a mining operation in Ok Tedi, a remote province 400 miles from the coast in Papua New Guinea. Altogether, several teams had to be coordinated between New Guinea, Australia, and a central office in Los Angeles.

Ironically, Bechtel does not use conferencing for its internal corporate communications. As is true for many organizations, messaging is accomplished by using switching networks, electronic mail, and similar systems. This may change as computer conferencing is exploited to relieve working groups of the need for extensive travel and real-time discussions.

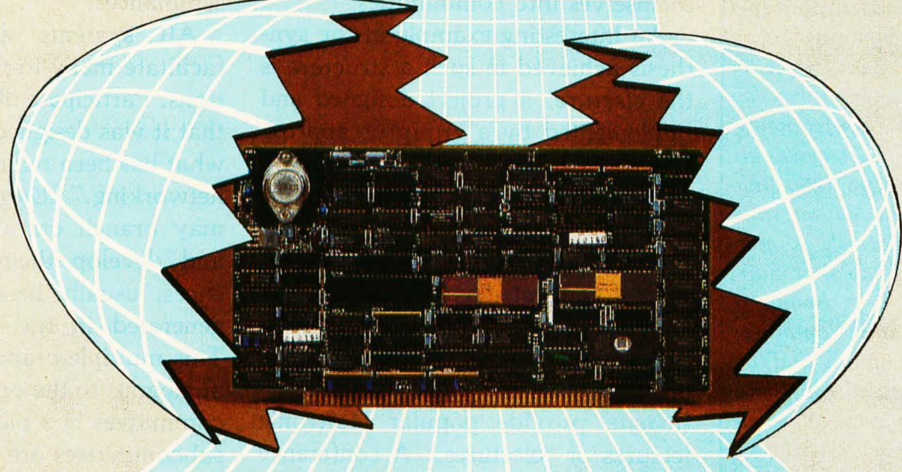
Two other computer-moderated conferencing systems, Confer and EIES (Electronic Information Exchange System), serve the needs of specialized study groups and business clients who "meet" online to develop documentation, examine specific problems, exchange data, and communicate with allied organizations. The Army's Delta Force, a network of consultants and Department of Defense specialists, uses Confer to examine future needs and organizational requirements. (See "Electronic Publishing" by Arthur Bechhoefer, page 124, for an account of another interesting application of Confer.)

EIES has been the site of professional-society committee deliberations such as those of the Instrument Society of America. Also, 10 hepatitis experts used EIES to organize a new database, the Hepatitis Knowledge Base, for the American Library of Medicine. The Hepatitis Knowledge Base is now available for downloading into physicians' microcomputers. In addition, Starr Roxanne Hiltz, coauthor of *The Network Nation* and sociologist studying acceptance of the new telecommunications technologies, has employed EIES to present online courses such as Telecommunications in the Future.

In 1978, a conference was organized on EIES, called Politechs, that included federal laboratories, state legislatures, local governments, public-interest groups, technical professional societies, and the White House. The conference was dedicated to promoting exchanges on the impact of science and technology on public policy. As a result of this conference, proposals have been made that aim at developing permanent interchanges for various departments of the federal government.

After the Three Mile Island incident in 1979, the nuclear industry responded by founding an Institute of Nuclear Power Operators that uses Notepad to tie together each utility

Incubation Complete



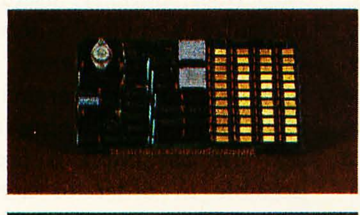
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Communitree: A Microcomputer-Based Conferencing System

An organization in San Francisco called the Communitree Group has developed a computer conferencing system for the Apple II. Designed as an alternative to the many computer bulletin boards around the nation, this system provides a relatively simple messaging structure capable of supporting complex branching communications— hence the name Communitree. In operation, you simply dial the system as you would any other bulletin board. You then obtain a list of parent conferences that can be accessed with a simple READ command. If the selected conference contains a subconference structure, the titles of the branch conferences will be displayed. You may browse as with more elaborate systems and enter messages with a simple line editor. Only the system operator has the power to delete or shift messages. Help files assist novices in learning the system's features.

This design is similar to The Source's Participate in that it provides a message-branching structure. Communitree is much more primitive, however, because machine limitations restrict the resources available to users, but the system's simplicity makes it easy to learn and very suitable for restricted applications.

To run the conferencing software, you must have an Apple II with 48K bytes of RAM (random-access read/write memory) and two disk drives. This will support a maximum of 320 fifty-line messages. The system deletes notes that are not current, and it can easily handle up to 35 users per day if it is kept online 24 hours per day. The Communitree Group also intends to develop software for other personal computers such as the IBM Personal Computer.

The source code is written in FORTH, and the cost of the program and manuals is $150.

Additional information may be obtained from the Communitree Group, Suite 207-3002, 470 Castro St., San Francisco, CA 94114.

with consultants, vendors, and numerous organizations.

Participate, a conferencing system that has recently appeared on The Source, has facilitated conferencing among disparate groups. These groups can subsequently organize themselves into communities.

An interesting example of the synthesis achieved in such a structure is the *electure*, a project designed and implemented by a group of approximately 20 participants within a three-month period. Jim Rutt, while serving as manager of Product Development for The Source, started with a concept developed by David Hughes, an early exploiter of computer telecommunications as a teaching tool, and suggested that Participate provide popular electronic lectures or "electures." A conference was started in which the members examined the scope, organization, and operation of an electure.

Despite the fact that many key members of the conference were periodically absent for extended periods, the group was first able to define the mechanism and procedures that were needed and then put the first electure online. The "electurer" was Starr Roxanne Hiltz, and the subject was the computer revolution—how the "electronic cottage" is changing the home. It appeared in seven segments, each segment followed by a ballot and a separate discussion conference. The electure became a powerful model for colloquia, seminars, electronic publishing, and structured telecommunications.

Where the Conferences Are

As of this writing, approximately a dozen commercial conferencing services are available in the United States. Some of these are run on central computers and can be accessed by terminals or microcomputers via packet-switching networks such as Tymnet and Telenet. Some can be licensed for use on a private mainframe computer. Most of these services are summarized in table 1. In addition, there is even a computer-moderated conferencing system that runs on a microcomputer.

It is difficult to compare the various conferencing systems because many were designed with different tasks in mind. This has led to certain structural and operational quirks peculiar to each one. However, because some features are shared, there are undeniable family resemblances.

All systems are designed to facilitate many-to-many communications. Participate differs somewhat in that it was designed to accommodate what has been referred to as "inquiry networking." Users of Participate may branch off a main conference and develop their own subconferences, usually based on an inquiry generated in the trunk discussion. This multiple-branching capability is analogous to the organization of subcommittees in a plenary session. The subcommittees are established to examine specific topics and then report back to the full committee. This structure facilitates the problem-solving aspect of conferencing.

Of course, any system that provides such opportunities for multiple-branched conferencing must also supply the user with means to maintain access and control. This requires a more complex set of instructions that can frustrate the unsophisticated subscriber. Initially, users may have difficulty knowing where they are within the conference hierarchy. Most computer conferencing systems have limited branching capabilities and use as simple a procedure as possible in order to achieve user-friendliness.

This does not mean that such systems are simple—far from it. EIES furnishes elaborate subdivisions for specialized information transfers, such as an electronic marketplace for buying and selling information and a "paper fair," a repository of research documents. Participate relies on its branching capability, which users must learn in order to tailor the system to their own needs.

Perhaps the most elaborate system is Augment, which gives the subscriber maximum control over all textual operations, from processing to multicolor page composition. Such a system requires a high degree of user knowledge and skill.

Com, the Swedish entry, has an extremely flexible structure that enables participants to track related messages via the links that interconnect them as a discussion grows. A single command is all that is needed to trace the

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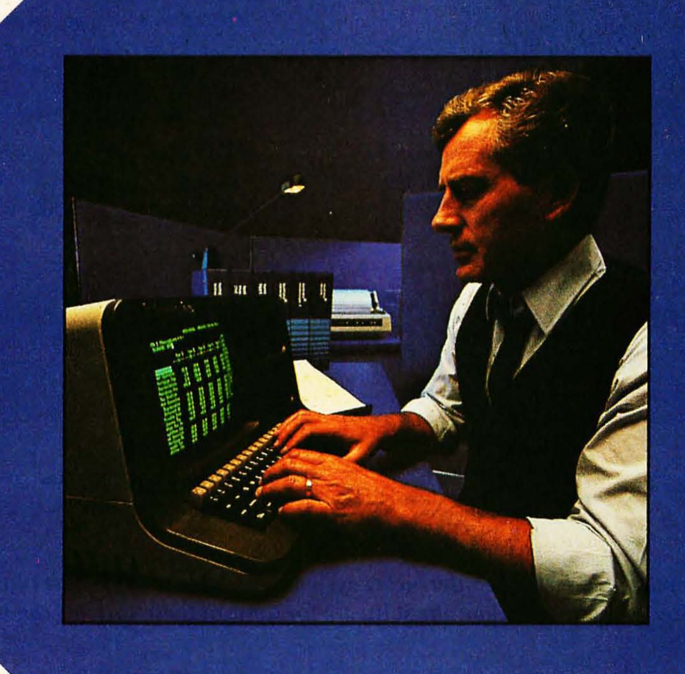
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System	Availability	Connect Costs	Processor
Participate Participation Systems Inc. 43 Myrtle Terrace Winchester, MA 01890	The Source; may be licensed	$20.75 to $5.75/hour; closed user group: $5000; licensing cost: $10,000 to $60,000	Prime computers
EIES Electronic Information Exchange System New Jersey Institute of Technology 323 High St. Newark, NJ 07102	Telenet, Univet, or direct dial	$75/month; group accounts: $200/month plus $10/month per user plus $8/hour	Perkin-Elmer 3230
Notepad Infomedia 801 Trager Ave., Suite 275 San Bruno, CA 94066	Tymnet; may be licensed	$10/hour average; closed user group: $1000/user plus $60/hour; licensing fee: $35,000	DEC-20 with TOPS-20 operating system
Confer Advertel Communications 2067 Ascot Ann Arbor, MI 48103	Telenet	$19/hour average	Amdahl 580
Hub Institute for the Future 2740 Sand Hill Rd. Menlo Park, CA 94025	Uninet; may be licensed	$30 to $40/hour; licensing fee: $40,000	DEC-20 with TOPS-20 operating system
Com Swedish National Defense Research Institute Stockholm University Computing Center Box 27322 S-10254 Stockholm Sweden	no subscription service; may be licensed	purchase cost: $14,000 ($7000 for universities); leasing cost: $4000/year ($2000/year for universities)	DEC-10; DEC-20
Genie Data Dynamics POB 5517 Portland, OR 97228	no subscription service; may be rented or licensed	rental cost: $15,000/3 months; licensing costs: $35,000	CDC Cyber 175; DEC VAX-11/780
MTX Matrix Transaction Exchange Cross Information Co. 934 Pearl Mall, Suite B Boulder, CO 80302	Telenet; may be licensed	$50 fee plus $25/hour; leasing costs: $1000/month and up	DEC systems
Augment Tymshare 20705 Valley Green Drive Cupertino, CA 95014	Tymnet; may be licensed	$14 to $18/hour; licensing cost depends on implementation	DEC-20 with TOPS-20 operating system

Table 1: *A list of commercial computer-moderated conferencing systems available today. Most of these systems can be accessed with either a microcomputer or a terminal. In addition, the software for some of these systems can be licensed for operation on a mainframe computer.*

complex branches of an involved discussion.

Computer Resources

One of the main advantages of computer-moderated conferencing is the ease with which you can access other very useful computer resources such as text editors, databases, and so on. Obviously you need an editor to process text that you will enter into conference discussions, and databases, programs, graphics packages, and instructional texts are all significant enhancements.

This support may be achieved by one of three strategies: putting the resources on the conferencing computer, accessing a separate resource computer over a network link, or implementing these resources directly on the user's microcomputer. In this last case, the conference computer may append one user's resource for the benefit of other users, although this is not the most important feature of such an arrangement. Obviously,

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line costs may be minimized if you can access these editing and programming resources offline. (I'll discuss this further in the following section).

EIES uses a microprocessor to dial out through Telenet to specific resources such as the New Jersey Educational Computing Network, which provides software packages for data analysis.

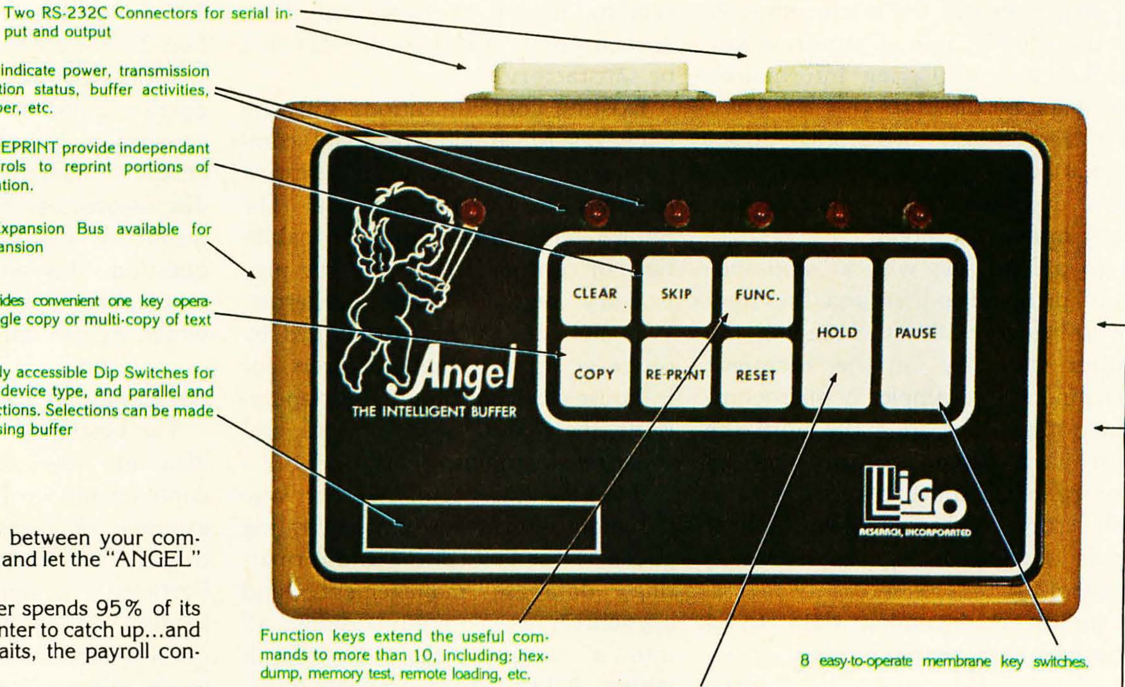
Designers of the Hub conferencing system from the Institute for the Future (IFTF) decided to support four basic activities: graphics, programming, documenting, and balloting. Upon conclusion of the developmental and testing phase of the system, Hubert Lipinski and Richard Adler of IFTF concluded that a more general method of achieving user-mediated access to resources is through a programmable microcomputer, so that connection to the conference computer and the resource computer could occur simultaneously.

Participate, as implemented on The Source, relies on the resources of the host computers in McLean, Virginia. These include various compilers; mathematical, statistical, and financial packages; and management modeling programs. The procedure for accessing these resources is complicated, however: the data must be processed outside the conference, the result placed into a file, and the file transferred into the conference.

Microcomputers as Terminals

As mentioned previously, you can reduce online charges by using a microcomputer (or intelligent terminal) capable of supporting text processing and a wide variety of communications tasks. A long document can be composed offline, edited, and then transmitted to the conference. Conversely, documents can be downloaded and read at leisure. And for the corporate executive with a hectic schedule or the computer hobbyist with little money, the microcomputer can wait until an appropriate time (say, after midnight when the network rates are lowest), dial into the conference, upload documents, download messages, and inform its user of the transactions the next day.

LET THE "ANGEL"™ DO THE WAITING ....



"ANGEL" is compatible with almost all Micro-Computers, including IBM, Apple, TRS-80, Vector Graphic, NorthStar, Altos, Xerox, Heath, Zenith, NEC, DEC, etc., with RS-232 serial, Hardware Handshaking, or Centronics compatible parallel interface. The manufacturer reserves the right to change the product specification.

Connect an "ANGEL" between your computer and your printer, and let the "ANGEL" do the waiting ....

Your valuable computer spends 95% of its time waiting for the printer to catch up...and while the computer waits, the payroll continues.

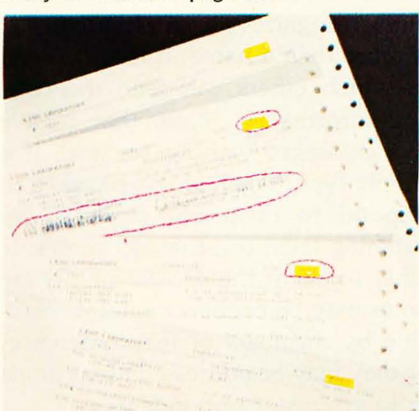
The computer sends data to the "ANGEL" at speeds up to 19.2K baud. The "ANGEL" stores data and sends it to the printer at a speed the printer can handle, and your computer is free to continue working without interruption.

A USER WRITES:

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PAGE REPRINT

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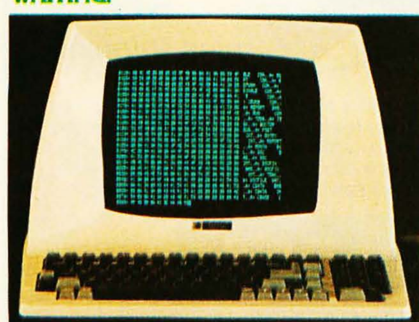
Pause and Hold for real time programs.

Page skip for selective printing. What a waste to print the entire documentation if you only need part of it.

Simple external switch settings, let the "ANGEL" accept either RS-232 serial or Centronics parallel data and can output either/or in any combination, (S-S,S-P,P-S,P-P). The "ANGEL" is compatible with almost all Micro-Computers, and can be installed by anyone in minutes. Switches are clearly marked for ease of operation, and a concise, USER FRIENDLY operator reference card is included with each unit.

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HEX DUMP

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Memory Size	64K	64K	64K	64K	62K
Max Baud Rate	19.2K	?	N/A	19.2K	?
Serial-Parallel	Yes	•	No	•	•
Parallel-Serial	Yes	•	No	•	•
Parallel-Parallel	Yes	•	Yes	•	•
Serial-Serial	Yes	Yes	No	Yes	Yes
Copy	Yes	Yes	No	Yes	No
Reset/Clear	Yes	Yes	No	Yes	Yes
Pause/Hold	Yes	No	No	Yes	No
Page Skip	Yes	No	No	No	No
Page Reprint	Yes	No	No	No	No
Continuous Copy	Yes	?	No	?	No
Self-Diagnostics	Yes	?	?	?	?
Hex-Dump	Yes	No	No	No	No

• Can only be configurated for one of the four Modes:

••Information based on available specifications from manufacturer's advertisement as of December, 1982

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The essential capabilities for a microcomputer communications software package are the following:

• to provide a *transparent talk* utility that relegates the microcomputer to the "dumb" role of inputting key strokes and displaying information sent back by the host
• to record into mass storage all information received in the talk mode
• to upload files to the host computer in the talk mode
• to upload files with a "stop-and-wait" protocol so that large files may be uploaded without exceeding the buffer capacity of the recipient machine (for example, a microcomputer might upload a file until the host machine sends a wait signal—a Control-S on most keyboards—and will resume uploading when the host sends a continue signal—usually a Control-Q)
• to divert incoming data to a printer if hard copy is needed

Many other capabilities are useful, and much depends on such factors as the data-transmission rate. With slow data transmission, the stop-and-wait protocol is usually not needed. If accuracy is essential, such as when sending binary or numerical data, asynchronous transmission may not be satisfactory.

Existing communications software packages for linking personal computers to such popular subscription facilities as Compuserve and The Source have rather limited capabilities. In contrast to this are the proprietary networks (e.g., Ethernet, Wangnet, and SDnet) developed by office equipment manufacturers for in-house electronic mail, Telex operations, the sharing of peripherals, and other telecommunications.

Recently microcomputer software designers have begun integrating packages for text editing and formatting, database management, and asynchronous communications all into a single system. One such system, MIST (Microcomputer Information Support Tools), was developed by Peter and Trudy Johnson-Lenz and is available from New Era Technologies for licensing on microcomputers using the CP/M 2.0 operating system (MIST requires 56K bytes of volatile memory and two 250K-byte floppy disks).

Ultimately, multitasking multiuser operating systems running on the new generation of microprocessors will enable conferees to access many discussions, databases, and computer resources simultaneously. Without question, this will elevate telecommunications into a new realm about which we can only speculate.

An Example: Participate

The best way to give you a good idea of how computer-moderated conferencing works is to show you an example of transactions with Participate on The Source. Getting into Participate is somewhat easy. After logging onto The Source and requesting command mode, all I have to do is type "PARTICIPATE." My terminal should then respond by displaying the following:

```
[PARTI Version 3.08]
Welcome to PARTICIPATE on the
Source, IRVING!
"PARTICIPATE" AND "PARTI" are
trademarks of Participation Systems Inc.
5 waiting notes.

Read, Scan, Batch, Cancel or Hold?
```

When a Source user asks for Participate, the conferencing computer automatically checks its memory to see if the account number is registered and what conferences the customer has access to. In this case, the computer recognizes me as "IRVING." It is more than a name, it is an address to which others can send messages and information. Note that I have five messages waiting for me. If I simply type "Read," I will be asked to respond to them one by one. By batching them together, I can decide what to do at the conclusion. These notes may be conference notes, readable by members of the conference, or they may be addressed to me alone or to groups of respondents.

Let's say I am involved with the engineering section at a computer man-

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Gentlemen, start your computers.

Time: 0

SELLING AND ADMINISTRATIVE INTERVAL SELECTION
Monthly –
Quarterly – x
Annually –
Other –
COMMAND: Example Help Load Next Quit Review Save
Type an "x" beside one choice
Press tab to move to command line
Expert System expense

Select budget intervals.

Time: 0.5

SALES REVENUE
Enter sales revenue for each quarter
1st Qtr 1983 $ 2560000
2nd Qtr 1983 $ 2655853
3rd Qtr 1983 $ 2964081
4th Qtr 1983 $ 3283348
COMMAND Example Help Load Next Quit Review Save
Enter responses
Press tab to move to command line
Expert System expense

Enter sales revenue.

Time: 1.0

VARIABLE SELLING EXPENSES EXPENSES INCURRED
List desired categories by typing in one category name per line
If suggested responses shown are not wanted delete them or replace them with your own preferred categories
Variable Selling Expenses 1 – Commissions
Variable Selling Expenses 2 – Other
Variable Selling Expenses 3 –
Variable Selling Expenses 4 –
Variable Selling Expenses 5 –
Variable Selling Expenses 6 –
Variable Selling Expenses 7 –
Variable Selling Expenses 8 –
Variable Selling Expenses 9 –
Variable Selling Expenses 10 –
COMMAND: Example Help Load Next Quit Review Save
Select option or type command letter
Press tab to edit responses on screen
Expert System expense

Enter selling expenses.

Time: 1.5

```
1          1            2       3        4          5
2  BUDGET PLANNING - SALES/ADMINISTRATIVE EXPENSES
3                          1983
4                   Pct of  Growth  1st Qtr    2nd Qtr
5                   Sales   Rate    1983       1983
6  ------------------------------------------------
7  SALES REVENUE                    2.560.000  2.655.853
8  VARIABLE SELLING EXPENSES
9    Commissions    1.00            25.600     26.559
10   Other          1.20            30.720     31.870
11 ------------------------------------------------
12   TOTAL VARIABLE SELLING         56.320     58.429
13
14 FIXED SELLING EXPENSES
15   Salaries                       112.140    112.140
16   Advertising                    100.000    100.000
17 ------------------------------------------------
18   TOTAL FIXED SELLING            212.140    212.140
19
20 VARIABLE ADMINISTRATIVE EXPENSES
21 Accounting       0.90            23.040     23.903
COMMAND Alpha Blank Copy Delete Edit Format Goto Help Insert
        Lock Move Name Options Print Quit Sort Transfer
        Value Window Xternal
Select option or type command letter
R2C1 "       BUDGET PLANNING          NL Multiplan TEMP
```

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Time: 5.2

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ufacturing company, and I have been using a conference on engineering to keep in touch with everyone. The following message illustrates a typical exchange:

> "NEW PRODUCTS" Conference 83.34
> HENRY, about "THE MANUFACTURE OF PORTABLE PRINTERS." (answers: 5)
> THUR, 01/27 13:35 (254 characters)
>
> The decision has been made to design and produce portable printers. The product is to be on the market by the middle of next year. All members of the engineering staff are to begin their preliminary discussions in this conference.
>
> Join to receive future answers?

This message alerts me to the fact that on Thursday, January 27, another conference participant, HENRY, organized a new conference called "NEW PRODUCTS"—the 34th conference of 1983 (83.34)—about the manufacture of portable printers, and that there are already five responses in the conference discussion. I can find out who has already joined and what the topics of the discussions are, or I can join for a while, participate in the discussion, and then leave or quit the conference. Once I leave, however, I will no longer automatically receive notification of new discussion entries each time I log onto the computer.

Let's say I want to start my own conference, "JOINT," to establish communication between the engineering department and the marketing department to help market portable printers. To do this I type "Write" or simply "W" in response to the computer prompt, "Disposition for 'NEW PRODUCTS'?" At this point, I can write my message in a special editable workspace—the scratch pad—set aside by the conference computer.

> This is to notify all members of the engineering staff that a joint marketing-engineering conference called "JOINT" Conference has been organized to coordinate activities. A preliminary market survey indicates that there are three manufacturers of portable printers with high inventories. Design failures may have been the largest factor contributing to their lack of sales, and it will be necessary to determine what was responsible for their poor performance.

The above message will be automatically appended to the "NEW PRODUCTS" Conference. At this juncture, I may use the editable workspace to organize the "JOINT" conference. As members of the engineering staff log onto the computer, they will be informed of my message concerning the "JOINT" conference and given the opportunity to join and participate.

This kind of communication system gives everyone the choice to enter, abstain, or simply monitor all goings-on. Only the moderator—the discussion editor—has the power to restrict membership, delete, or modify what has been recorded in the conference. It makes no difference whether HENRY and I are separated by a few feet or 10,000 miles, by seconds or days.

The Computer as Publisher

Some large corporations, primarily those involved in computer technology, have begun to experiment with automated conferencing as a tool to facilitate their developmental work. The Massachusetts Institute of Technology's Center for Information Systems Research has been using Participate to run a conferencing project for a number of corporations. The MIT program has been particularly successful in using Participate to organize meetings and to explore specific conference topics. Notepad was used to organize the Spring 1982 Office Automation show in San Francisco.

In the past, a major meeting required careful planning and volumes of communication, but when the preparatory work is handled in a computer conference, the content and scope of a meeting are easily developed. Computer conferencing cannot substitute completely for all meetings, of course, but it can greatly increase the productivity of meetings when they do take place. Such conferencing also includes a democratizing feature: the organization is open to criticism and discussion among all conferees.

This immediately points to a poten-

Some people drive fine German machines to work. Some people drive them once they arrive.

The tradition of high quality, high performance German craftsmanship and engineering is legend. And while we most often see that tradition in action on America's streets and highways, it is in America's business offices that its future holds the most promise.

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This powerful small business computer passes higher-priced competitors with ease. Its dual processors — for CP/M® and Apple II® compatibility — open up the largest library of microcomputer software and plug-in peripherals available today.

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The BASIS chassis is cast aluminum, eliminating heat and RFI interference problems. And there's plenty of room for internal expansion to include hard disk drives and other peripherals.

The BASIS 108. Microcomputing's "Best Of Both Worlds." German craftsmanship and American business savvy. CP/M-based business computing and Apple II-based personal computing. High performance and a surprisingly low cost. The BASIS 108. A computing machine finely tuned to handle the fast tracks of business today.

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Circle 58 on inquiry card.

tially important new application. Computer conferencing may be ideally suited to filling certain gaps in publishing. Consider this: with a computer terminal connected to a network, the user has potential access to thousands of information libraries or databases—from the New York Times Consumer Data Base to the Library of Congress Card File. There is no substantial publisher of data that does not put at least part of its information into computer storage. Some commercial information services such as Dialog, a subsidiary of Lockheed, have access to over 45 million records in more than 120 databases on business, science, medicine, technology, the humanities, and politics.

The computer facilitates the search for meaningful information by providing highly selective search strategies. It is no longer true that the proliferation of information is threatening to deluge us with meaningless drivel. The problem is the opposite. Information is not being produced fast enough.

Particularly troublesome is the fact that some scientific and medical articles take a year or more after submission to a journal before emerging in print. Also, the processing of economic statistics can be excruciatingly slow. Such delays are not acceptable. We need more information faster if we are to be able to correlate and organize the diverse pieces necessary to make coherent and prompt decisions.

One exciting solution is for scientific societies to supplement their publishing operations with computerized conferences in which information exchanges can be conducted and subjected to the critical scrutiny of their members. Specialized research groups can also conduct exchanges, partially in public or wholly in private, in order to accelerate the interchange of ideas and data. Ongoing dialogs can be developed and nurtured along diverse, interdisciplinary lines, merging with specialists in different groups when necessary.

The Collective Intelligence

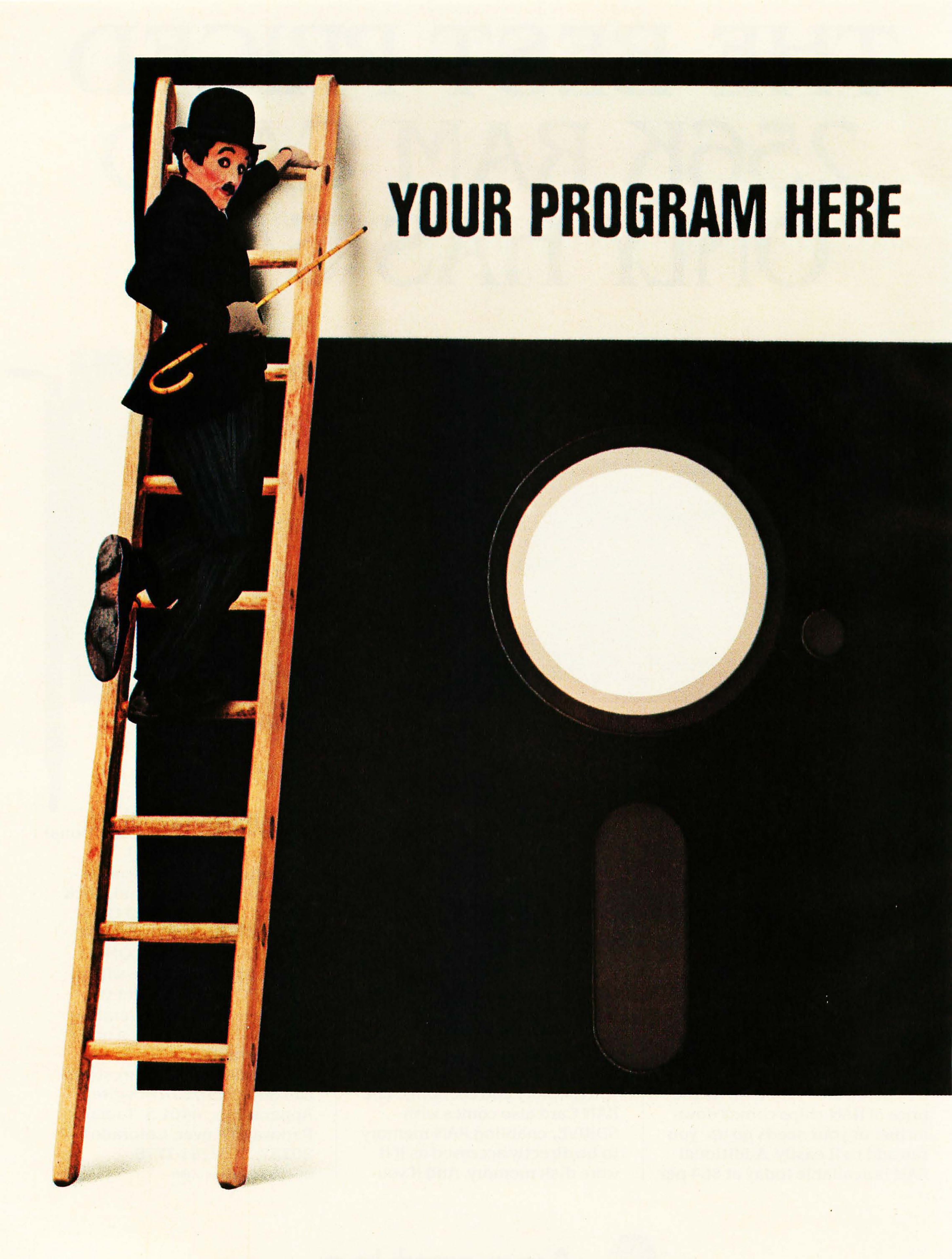
The marriage of cable television with computer technology has already led to a limited form of mass conferencing in certain test markets. On the Qube system in Ohio, subscribers can respond to inquiries, participate in votes, play games, and obtain information through a communications link with their cable service.

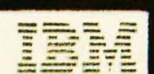
In the future—especially as videotex services become more popular—electronic mail, commercial transactions, conferences, magazine abstracts, local reports, and public-interest announcements will be integrated into our daily routine.

How the institutions of our society—business, government, universities, laboratories—will be changed by this technology is difficult to assess. The process of communicating creates new information: new designs for equipment, solutions to marketing problems, the synthesis of scientific and technical knowledge, the testing of hypotheses, the hard work of whittling fact from the raw material surrounding it. And the more people communicate, the more new information will become available. Once expressed, an idea will become part of a percolating turbulence of thought, criticism, and judgment—a collective intelligence.

There will be dangers, however. Information vendors may assume tremendous power; no antitrust laws govern the managment of ideas. The great institutions may acquire even greater authority, and a suffocating superclass might emerge to stifle the innovations of the future. Privacy may be difficult to maintain, and privileged information may become the prey of unscrupulous individuals and institutions.

What we gain, however, will be more than what we hazard losing. We will live with a wealth of ideas, in a firmament of information as enormous as the whole of human knowledge. ■


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†UCSD p-System is a trademark of the Regents of the University of California. CP/M-86 is a trademark of Digital Research, Inc.

Electronic Publishing

The New Newsletter

How a traditional newsletter became a computer-accessed, interactive investment advisory service.

Arthur S. Bechhoefer
Independent Investors Forum
1640 Argonne Place, NW
Washington, DC 20009

Computer conferencing is gaining popularity as a solution to the time and place restrictions of conventional business meetings; however, the techniques involved readily lend themselves to other uses. Through the example of the Independent Investors Forum (IIF) I'll show how such conferencing techniques can be applied to the field of newsletter publishing to develop an information service that is highly receptive to the needs of its audience.

Not long ago I found the opportunity to publish a small newsletter for stock market investors. In designing this publication, I had two principal objectives. First, the publication would have to be profitable, even though it would probably circulate to fewer than 500 subscribers. Spreading investment advice to a larger audience, as is done in many newsletters and most notably on public television's *Wall Street Week*, destroys the value of the advice: too many people act on it before you get a chance.

Second, because I wanted the publication's information to help individuals make investment decisions that best meet their own needs, people ought to have some input into the editorial process. They should be able to question the research staff, offer their own opinions, and ask other subscribers what they think. (In practice on the IIF, not only does this dialogue produce better decisions, it keeps our research staff honest. That's why we tell our clients, "Our advice is questionable.")

This second objective presented me with an interesting new application for my personal computer. Originally I had intended to use it simply as a word processor to produce clean copy suitable for a biweekly newsletter. But even a computer novice like me could see at a glance the advantages of a computerized investment service over traditional market advisory letters. The major benefit, of course, is the elimination of the time needed for preparing hard copy and mailing it to subscribers. Investment advice often loses its value rapidly. Timing of purchases and sales is critical, especially for the small investor. With a computer and communications equipment, you can get all the information instantly.

An electronic mail or bulletin board system would be one way to meet this need for rapid communication. But the problem with these systems is that the user often likes to refer back to certain articles and to skip over other articles entirely. The user needs to be able to sort through the entire data file quickly to minimize connect-time costs and to avoid eyestrain from looking at a video display that, in the case of most home systems, is pretty unsophisticated.

Compared with hard copy, the average home computer terminal leaves a lot to be desired. There are no fancy type styles, no photos, and very limited graphics. Everything merely scrolls up a phosphor monitor that displays at best only 80 columns of text. How much of that can you take before you get bleary-eyed or just plain bored? We had a hunch, confirmed by subsequent research,

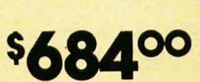
Editor's Note:
For more information on computer-moderated conferencing, see the article entitled "The Movable Conference," by Irving Lerch, also in this issue on page 104.

About the Author
Arthur Bechhoefer has a doctoral degree in Urban and Regional Planning from the University of Michigan. He is the director of the Independent Investors Forum, the first commercial application of computer conferencing techniques to newsletter publishing.

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The "ENGINEER'S" computer is available in three powerful versions offering real-time Tiny BASIC.

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**Supplied with 16K EPROM, 6K RAM, 2.5K ROM.*
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K-8073A

The Satellite Tiny BASIC Computer
Features:

- INS 8073 microinterpreter MPU
- On-board, real-time clock
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For stand-alone control applications, the K-8073A provides a low-cost alternative. After software has been developed, the small K-8073 module can be installed just about anywhere. As a satellite, the K-8073A can report or receive instructions from a host computer.

24K BYTE SINGLE UNIT **$478.00**



K-8073A



K-8073

K-8073

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"Listening in" on the Independent Investors Forum

The following is an edited series of responses on the IIF. Note that although the item was originally dated June 1982, a participant was able to join in November and get an update.

Item 1 08:56 Jun14/82 20 lines
Arthur Bechhoefer
June Recommendations—
Fruits of Labor

Despite the poor functioning of the economy, there are STILL some stocks worth considering. For June, I continue to recommend high technology stocks in markets that are growing steadily or that have at least cyclical growth potential.

As I noted last month, my two choices continue to be Apple Computer, because of a better than 30 percent growth in the personal computer market, and Cherry Electrical Products, a manufacturer of microswitches, computer keyboards, and "dedicated" semiconductor circuits for cameras, smoke alarms, and other control apparatus.

You're certainly big on fruit. How about meat and potatoes?

The only item along that line I recommend is Prime Computer, which unlike its two main competitors—Digital and Data General—continues to post profit gains from quarter to quarter and has had recent purchases of its stock by officers and directors. . . .

Six Discussion Responses

1) Howard Finney: How do you feel about DEC overall?
2) Art Bechhoefer: Last May, as reported by the Securities and Exchange Commission, five of Digital's officers sold roughly 10 percent of their stock holdings at prices ranging from $76 to $81. With the stock currently about $84, I think I'd go along with the insiders and sell too, if I owned it.
3) Peter Hollidge: Art, it's now November. Do you still feel the same about Apple?
4) Art Bechhoefer: Peter, yes, basically I feel the same way. See item 31 for an update. I tend to think that the market as a whole is too high right now (November 3) but remember that Apple has been lower relatively speaking, due to Steven Jobs' having sold a bundle of shares to finance a music extravaganza last August.
5) Carolyn Allen: Art—it was Steve Wozniak who blew a bundle on the US festival.
6) Art Bechhoefer: Right you are. Anyway, same difference. A lot of stock went on the market and kept Apple prices artificially low. This was coupled with skepticism in the investment community concerning lack of a new computer to update the Apple II.

that the limit was something like 4 minutes for an article and not more than 10 or 15 minutes for an entire session, including the time to sign on, request the information, read it, and decide on subsequent action.

If we examine these constraints in terms of what they mean for stock market advice, we find that our research articles could cover only basic points—the main reasons behind our buy, hold, or sell recommendations. But the user might be left with quite a few unanswered questions concerning the research data as well as other possible investment alternatives. This suggests that some method for requesting more information, such as two-way communication, is essential in electronic publishing.

Two-way communication provides a basis for dialogue and thus enhances information transfer and learning. What is true for scientists, engineers, or any other professionals, applies equally to those providing investment advice: no one has perfect information. No one has a monopoly on expertise. Some people specialize in one area, some in another. A well-formed investment decision is the product of all the best available information, given the constraints of time and cost. Dialogue speeds the transfer of information and thus makes learning and decision making more efficient.

To facilitate two-way communica-

The new COMPAQ Portable Computer. IBM compatibility to go.

Simple, isn't it? The COMPAQ™ Portable Computer can do what the IBM® Personal Computer does. To go.

It runs all the popular programs written for the IBM. It works with the same printers and other peripherals. It even accepts the same optional expansion electronics that give it additional capabilities and functionality.

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If you use a portable typewriter, you can use the COMPAQ Computer as a portable word processor instead.

If your company already uses the IBM Personal Computer, add the COMPAQ Portable as a mobile unit that can use the same programs, the same data disks, and even the same user manuals.

There are more programs available for the COMPAQ Computer than for any other portable. More, in fact, than for most non-portables. You can buy them in hundreds of computer stores nationwide, and they run as is, right off the shelf.

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The bottom line is this. The COMPAQ Computer is the first uncompromising portable computer. It delivers all the advantages of portability without trading off any computing power capability.

And what do those advantages cost?

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The COMPAQ Portable sells for hundreds less than a comparably equipped IBM or APPLE® III. Standard features include 128K bytes of internal memory and a 320K-byte disk drive, both of which are extra-cost options on the IBM. Memory and additional disk drive upgrades are available options to double those capacities.

In the standard configuration, the COMPAQ Computer has three open slots for functional expansion electronics as your needs and applications grow. It accepts standard network and communications interfaces including ETHERNET™ and OMNINET™.

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tion, I chose a computer conferencing system available on the Michigan Merit network. The system, known as Confer II, runs on an IBM 3081 or Amdahl equivalent and is accessed from any of five network host computers via GTE's Telenet network or leased outside lines. Confer II has a number of features that, while not unique, are eminently well suited to electronic publishing:

- The computer conference organizer (editor) can easily create agenda categories for the different types of information that will be presented. The agenda is similar to a table of contents in a magazine.
- The user (reader) always has a chance to respond, discard, or pass on each item (research article) presented. The user can select the latest items and literally throw away the rest, or just read summaries or items dealing only with certain subjects (stocks, industries, investment strategies, and so forth).
- The ability to respond at any time, either openly for all participants or privately for selected individuals, means that the more timid participants don't get shouted down or brushed aside. Conversely, the more assertive participants soon learn that long responses cost more. In some ways these features actually improve the quality of dialogue beyond what might occur in a real-time teleconference or face-to-face meeting. In the context of a publication, it is far livelier than a standard Letters to the Editor column.
- The focus of the conferencing system is on making decisions, not just sharing information. The system software encourages users to contribute information, suggest topics for future research, vote on the conference agenda, or express their preference for particular investment alternatives.

The net effect of these features from the organizer's (i.e., editor's) point of view is to have at one's fingertips a vast amount of feedback, making it possible to provide what the *users* want, not what the organizer or editor *thinks* they want. From the

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point of view of the researcher, it puts an end to the notion that there are only a few experts whose words are infallible.

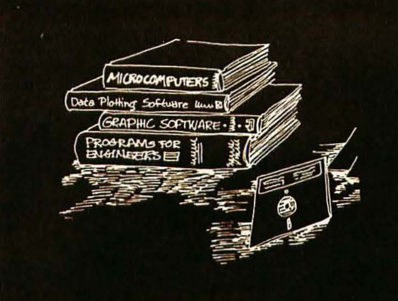
As for the users, our information indicates that they prefer spending no more than 15 or 20 minutes online per session. They sign on mostly during weekends or holidays, thereby reducing their connect-time costs by about 10 percent. Also, if they have appropriately equipped personal computers, they can download items from the host system and store them on disk. The items can then be read at the users' leisure, and connect time will be reduced. Similarly, users can prepare messages on their personal computers before going online, and then quickly upload the messages into the host system, saving even more time.

Although users of the Independent Investors Forum have some difficulty mastering the numerous system commands at first, their capabilities improve quite rapidly, as evidenced by the accuracy and appearance of their responses and other communications. When troubles occur—and they do—the user can call us by telephone. We have a technical advisor who provides advice either over the telephone or online. We also have a tutorial to make the system easier for beginners. A professional conference facilitator helps everyone participate actively, and a monthly user's guide provides technical tips and research articles more suitable for hard copy. Nearly all users who initially selected a 60-day trial membership have converted subsequently to a full year.

In the future, we hope to expand this form of electronic communication by publishing other journals and newsletters for those who need to keep up on what is happening in their field now, not three months from now. Also, because of this system's low cost in comparison with on-site meetings or video conferencing, it would probably be useful for maintaining contact between various divisions or field offices in a corporation. Or it could be used for conducting training seminars without disrupting anyone's work schedule or straining a limited travel budget. All in all, computer conferencing should have a fairly significant impact not only on the way we gather information, but also on the way we work. ■

Accessing the IIF

The Independent Investors Forum can be accessed by any microcomputer or terminal equipped with a modem and an appropriate communications software package such as ASCII Express "The Professional" from Southwestern Data Systems (POB 582, Santee, CA 92071; (714) 562-3670) or Crosstalk from Microstuf Inc. (1845 The Exchange, Suite 140, Atlanta, GA 30339; (404) 952-0267). Communication is available at either 300 or 1200 bits per second. A one-year membership in IIF costs $300, plus telephone connect charges ($19 per hour, average). A 60-day trial membership costs $125 and includes 3¼ hours connect time. Membership and telephone charges may be tax-deductible as investment expenses.



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This complete graphics self-teaching guide will show you how to write your own 2 and 3 dimensional graphics software quickly and easily.

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Math level is kept to a minimum and new concept are explained as they are used.

Named "The Best Book on Microcomputer Graphics" by Creative Computing magazine.

☐ **Manual with Disk(Apple) or Tape(TRS-80 Color Computer): $45**

Data Plotting Software for Micros

This softkit contains a system of 18 complete programs which process and display data: pie charts, bar charts, stock market charts, histograms, 3D views of surfaces, log plots, curve fitting, data management, histograms and statistical analysis.

Programs are modular, menu driven, written in BASIC, fully explained and keyed to theory. They are listed in the book alongside theory and equations. Use as-is or modify to suit your own applications.

Four data base management programs are included. These create x, x-y, x-y-z and stock market data files and store them on disk. Plotting programs read the data files and carry out sorting, statistical analyses and plot results.

Features include automatic scaling, axis marking and numbering, auto replot when data changes, and a special program called **LABELER** which places text and symbols over graphics using a moving cursor.

☐**Manual with Disk(Apple or IBMpc) or Tape(TRS-80 Color Computer):** $48

Engineering Software for Micros

This softkit contains 25 fully-documented programs for computer-aided design and analysis on micros. They will show you how to write modern CAD software or they can be used as-is for professional engineering work.

Emphasis is on combining computer graphics with engineering problem solving. Programs are included to interactively create engineering drawings, store them on disk, recall, update, merge, add physical properties such as resistance, thermal capacity and density, and rotate in 3 dimensions to produce isometric views.

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All programs are menu driven, written in BASIC and fully documented and keyed to theory and equations.

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IBMpc Graphics

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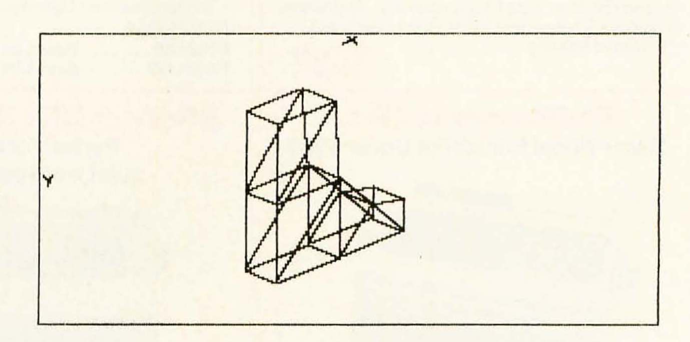
Learn how to create 2D and 3D shapes, translate, rotate, scale, stretch, clip, remove hidden lines, shade, create perspective views, calculate and plot surface intersections, produce animations effects, store graphics on disk.

Applications to science, education and business included. Also covers hardware needed for PC graphics, use of the PC's special graphics enhancements, and how to separate text from graphic on the PC's sceen.

Contains 61 programs arranged in a tutorial manner leading from one step to the next. Math level is kept to a minimum and new concept are explained as they are used.

Much of this softkit is based on the popular **Graphic Software for Microcomputers** by B.J. Korites which was named "The Best Book on Microcomputer Graphics" by Creative Computing magazine.

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Other programs analyze trusses with large deflections and nonlinear material properties. These use an incremental solution strategy. Also included are programs which calculate combined stresses and properties of beam cross sections.

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This system of programs is patterned after large-computer structural analysis systems such as ADINA and SAPP, but reduced in scale for micros. They were written by B. J. Korites, PhD, former CAD/CAM consultant to the Arthur D. Little Company.

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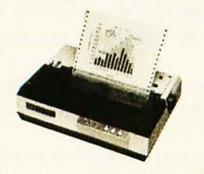
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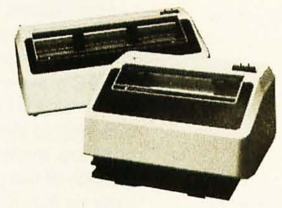
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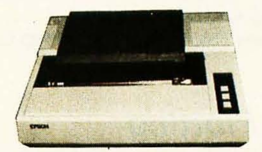


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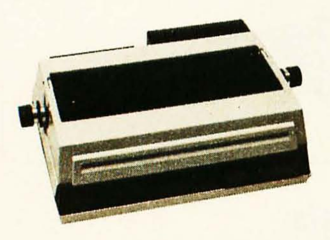


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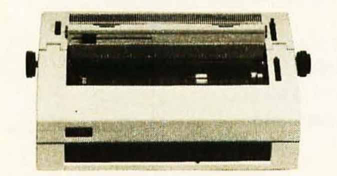
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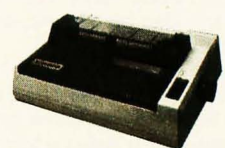


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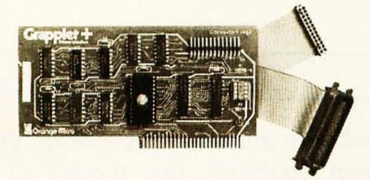
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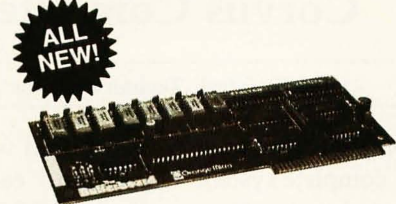
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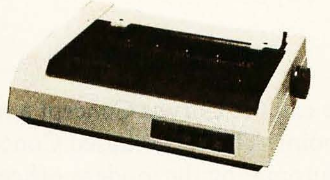
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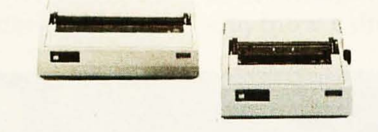


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What a Concept!

A View of the Corvus Computer

Curtis Feigel, Technical Editor

To call the Corvus Concept a microcomputer is to miss the point. The 68000-based Concept is a complete system for automating the modern office. Not merely a workstation or a personal computer (although it can be either), the Concept consists of software and hardware modules designed to work together in an office environment.

Getting personal computers to perform useful functions has always been a challenge for designers and programmers. Heretofore, we have had a variety of off-the-shelf solutions to the problems of financial planning, text editing, and communications. Until now, however, if you wanted a spreadsheet that worked with a word processor that worked with a local-area network, you needed to buy each item separately, then modify all three so they would work together. Corvus has done this job for you by combining these functions in one easy-to-use package.

The Concept, which uses a Motorola 68000 microprocessor running at 8 MHz, comes standard with both 256K bytes of memory (expandable to 512K bytes) and an Omninet local-area-network interface. In addition to its two serial ports, the Concept has four I/O (input/output) expansion slots that accept Apple II peripheral cards. The machine features a bit-mapped video display in a full-



Photo 1: *Two Concepts linked to a 6-megabyte hard-disk drive (center) via an Omninet local-area network. An 8-inch thin-line floppy-disk drive (right) is connected to a controller board installed in the Apple II-compatible expansion bus of the Concept on the right. The video display on the right is set up in the portrait format, almost the exact size and shape of a sheet of paper. The monitor on the left has been rotated 90 degrees for viewing in the landscape format.*

At a Glance

Product
Corvus Concept

Manufacturer
Corvus Systems Inc.
2029 O'Toole Ave.
San Jose, CA 95131
(408) 946-7700

Components

Processor Unit: 8-MHz Motorola 68000 microprocessor; 256K bytes of memory; two RS-232C serial ports; Omninet local-area network; four Apple II-compatible expansion slots
height: 4 3/8 inches
width: 16 7/8 inches
depth: 15 1/8 inches
weight: 28 lbs

Display: 14-inch (diagonal measure) high-resolution black-and-white video monitor; 8 1/2 by 11 1/2 viewing surface; tilt and swivel mounting on top of processor unit; monitor can be rotated 90 degrees to provide either portrait (545 by 639 pixels, 63 lines of 90 characters) or landscape (707 by 479 pixels, 47 lines of 117 characters) aspect ratio
height: 15 inches
width: 13 1/2 inches
depth: 14 inches
weight: 36 lbs

Keyboard: standard typewriter layout with numeric keypad and 10 software-definable function keys; detached from processor unit with 9-foot coiled cord
height: 3 3/8 inches
width: 16 7/8 inches
depth: 8 inches
weight: 6 lbs

Cost
$4995 ($5995 for 512K bytes of memory)

Hardware Options

Hard-Disk Drive: choice of 6-, 10-, or 20-megabyte-capacity drives (one required); can interface to single workstation via I/O-expansion controller board or to multiple workstations via Omninet network interface
height: 5 3/4 inches
width: 12 inches
depth: 15 1/5 inches
weight: 18 lbs
cost: 6-megabyte $2495
10-megabyte $3495
20-megabyte $4495

Mirror Unit: installs between hard-disk drive and user-supplied video-cassette recorder; backup times are approximately 1.8 minutes per megabyte
height: 3 1/4 inches
width: 7 1/2 inches
depth: 13 1/8 inches
weight: 10 lbs
cost: $790

Floppy-Disk Drive: Tandon thin-line 8-inch floppy-disk drive in external case that interfaces to processor via I/O-expansion controller and 50-conductor ribbon cable
height: 10 1/4 inches
width: 4 3/4 inches
depth: 16 inches
weight: 14 lbs
cost: $1500

Software

Operating System: CCOS (Corvus Concept Operating System), designed specifically for the Concept, accepts most commands from the keyboard's special-function keys (cost included in package price)

Languages: FORTRAN-77 compiler cost: $445
Pascal compiler included with floppy-disk drive

Applications: EdWord text editor accepts most commands from the keyboard's special-function keys
cost: included with floppy-disk drive

LogiCalc spreadsheet program accepts most commands from the keyboard's special-function keys
cost: $195

CP/M emulator imitates Intel 8080 microprocessor running CP/M; allows mass storage on hard disk and is capable of accessing IBM 3740-format single-density 8-inch floppy disks
cost: $295

page format. It also includes a detached keyboard whose 10 function keys match the software-generated menus. Thin-line 8-inch floppy-disk drives are available. A required hard-disk subsystem and optional companion video-tape interface can connect to the unit or to the Omninet network for access by more than one Concept (see photo 1).

Because the 68000 microprocessor is relatively new and independent vendor software for the Concept is far from abundant, Corvus supplies two of the most important programs: the LogiCalc spreadsheet program and the EdWord word processor. The company also provides two high-level languages, Pascal and FORTRAN, as well as a CP/M emulator.

The Workstation Approach

Its designers intended the Concept to be an individual workstation operating within a local-area network. With this arrangement, each user receives the full resources of a computer, but can also share both information and peripheral devices. The networked computer offers some attractive cost advantages and allows several people to work simultaneously on the same task.

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Photo 2: *The keyboard features 10 function keys (F1 through F10) above the standard QWERTY layout.*

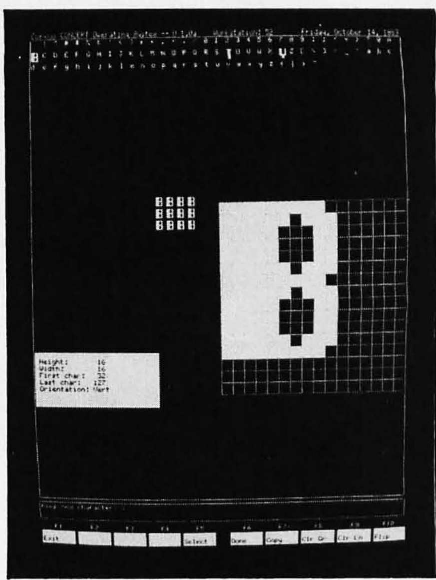


Photo 3: *The character editor allows the user to customize and redesign the displayed characters.*

A second feature of the Concept workstation is the absence of individual mass storage. Whenever a system must process large amounts of data, hard-disk drives are a necessity. Because these drives are expensive, providing one for each user can be too costly. For this reason, the Concept allows several users to share a single hard disk.

Corvus also realizes that the office market contains many potential users who know little about using computers. All the bundled software programs—including the operating system, spreadsheet, and text editor—focus on people who want to use a computer with their work, but who don't want to solve puzzles to make that happen. In fact, the software menus make it possible for a computer novice to use either the spreadsheet or text editor with less than an hour of tutoring.

Fingers and Keys

The Concept detachable keyboard has 91 keys in a standard typewriter layout with additional function keys and a calculator pad. In addition to the standard features, you get three keys labeled Fast, Alternate, and Command. Although any key will automatically repeat when held down for more than one-half second, pressing the Fast key simultaneously increases the repetition rate. The Alternate key works like the Control key in special applications.

Across the top of the keyboard are the special-function keys, arranged in two groups of five (see photo 2). These keys correspond to menu selections appearing at the bottom of the display screen. The Command key allows you to toggle between menu selections when more than 10 functions are available for a particular application. The function keys also let you select additional menus. After a bit of practice, your speed with the function keys can become quite impressive because they make it unnecessary for you to memorize and type a complex command. Additionally, the Concept's keyboard buffer lets you rapidly enter commands, while the machine continues to execute them in order. If you forget what a function can do, pressing the Help key and then a function key produces a description of the second key's function.

A New Look

If the Concept's keyboard is a good idea, the video display is an amazing one. It sits atop the processor cabinet secured by a swivel joint that lets you tilt and pivot it as you wish. In its vertical position, which is great for text editing, the screen contains 90 columns by 63 lines in a display about the size of a sheet of notebook paper. You can also unlock the display, rotate it 90 degrees, and secure it in the holder to get a display of 117 columns by 47 lines, which works well with the spreadsheet. Besides the option of two display modes, the Concept offers both white-on-black and black-on-white characters. You have a choice of supplied type fonts and can also create your own character sets. A large blank matrix lets you redefine characters using a process similar to painting (see photo 3).

The video display also divides into windows or rectangles of user-defined ratio and size. Each window becomes an independent display area with its own attributes, providing the user with a powerful and convenient feature. In a window you can show text in any font, display black or white characters, and scroll the text independently of the rest of the display. For example, you could use EdWord to write a report while creating a separate window of information from a LogiCalc model.

Under the Hood

Considering all the functions that the Concept provides, the hardware formula is simple: combine the

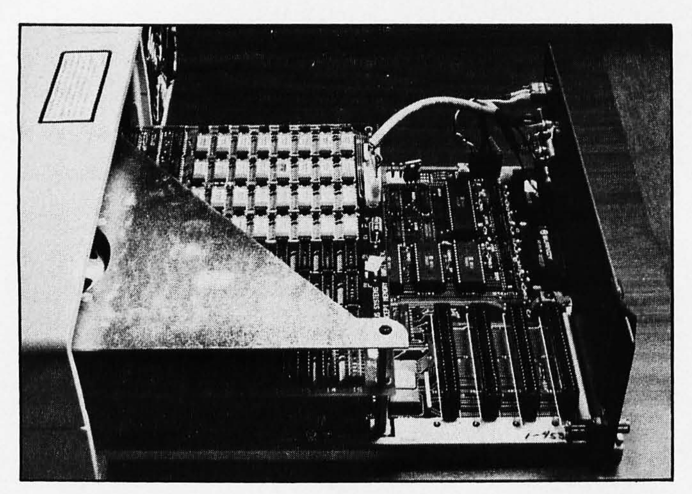


Photo 4: *The drawer containing the Apple II-compatible expansion connectors.*

Dispatcher Functions

ClrWndow	Clears the current window, leaving cursor in upper left corner
Const II	Runs the Constellation II utilities; produces its submenu
CP/M	Runs the CP/M emulator
CreWndow	Allows creation of windows on the video display
EdWord	Runs the word processor; produces its submenu
ExecFile	Executes a file of commands
FileMgr	Runs utilities for maintenance of files; produces its submenu
Help	Produces a help message for any function label
LogiCalc	Runs the spreadsheet program; produces its submenu
ListVol	Lists all volumes online or names of all files on a disk volume
MountMgr	Runs utilities for mounting disk volumes; produces its submenu
Restart	Causes the system to be completely reloaded from disk
RevBackgnd	Reverses the background color of the current window
SelWndow	Assigns one window as the current window
SetVol	Used to select which volume is to be current
SystmMgr	Runs utilities for setting system attributes; produces its submenu
WndowMgr	Provides functions for setting window characteristics; produces its submenu

Table 1: *The Concept's functions are accessed via a series of menus beginning with the Dispatcher level.*

16/32-bit architecture of the 68000 with a large amount of RAM (random-access read/write memory). Most of the flexibility and many of the special features of this system result from this combination of power and memory. For instance, the microprocessor positions each of the screen's 350,000 pixels, which allows you a variety of display options such as windows and programmable character sets.

Access to the outside world comes from an Omninet local-area-network interface and the capability to use Apple II peripheral cards. The Omninet network provides users with one of the best-defined network standards in the marketplace and provides the convenience of local communication and rapid data-transfer rates necessary to many business applications. By duplicating the Apple II expansion bus, the Concept can take advantage of the hundreds of expansion boards already on the market (see photo 4). In addition, Corvus did not forget the need for local I/O devices and provides two RS-232C serial ports for connection to a printer and modem.

Software Details

The Concept uses menu-driven software that appears to the user as a single hierarchical system. From the operating system to the lowliest editing command, all functions are menu items. At any point, your options are obvious and you can easily move to the previous or following menu. The first menu of available functions, the Dispatcher level, presents all the major software features (see table 1). This level, similar to the operating system in other computers, gives you a choice of four menus: File Manager, Window Manager, System Manager, and running programs. Selecting any of these options produces a submenu of choices, and some of those choices produce still further menus.

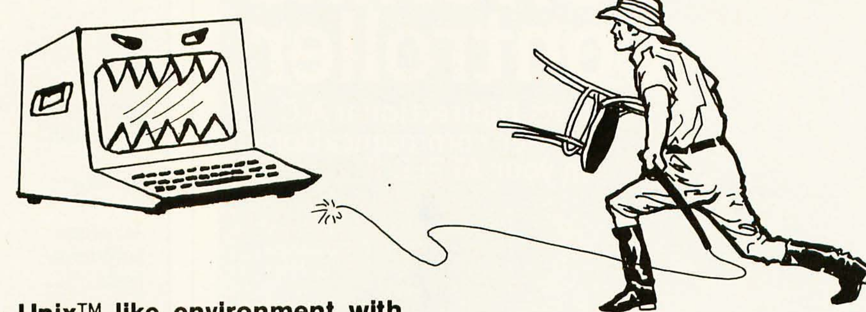
File Manager becomes a frequent choice because the Concept requires that you divide the hard-disk storage into separate volumes to limit information access to particular users. While the size may vary, each volume has a name and a directory, much like a floppy disk. When you

File Manager Functions

ClrWndow	Clears the current window, leaving cursor in upper left corner
ConcFile	Concatenates files
CreWndow	Allows creation of windows on the video display
Crunch	Reclaims unused disk space within a volume
CopyFile	Copies disk files
DletFile	Erases disk files
DletTemp	Erases a temporary disk file from a volume
Exit	Returns to previous menu
Help	Produces a help message for any function label
ListFile	Lists the contents of a text file
MakeFile	Creates a disk file
MountMgr	Runs utilities for mounting disk volumes; produces its submenu
RevBkgnd	Reverses the background color of the current window
Rnamfile	Changes the name of a disk file
SelWndow	Assigns one window as the current window
SetVol	Used to select which volume is to be current
Spool	Sends output to a temporary disk file from which it may be read and printed elsewhere on the network

Table 2: *Disk-file-management functions are available through the File Manager menu.*

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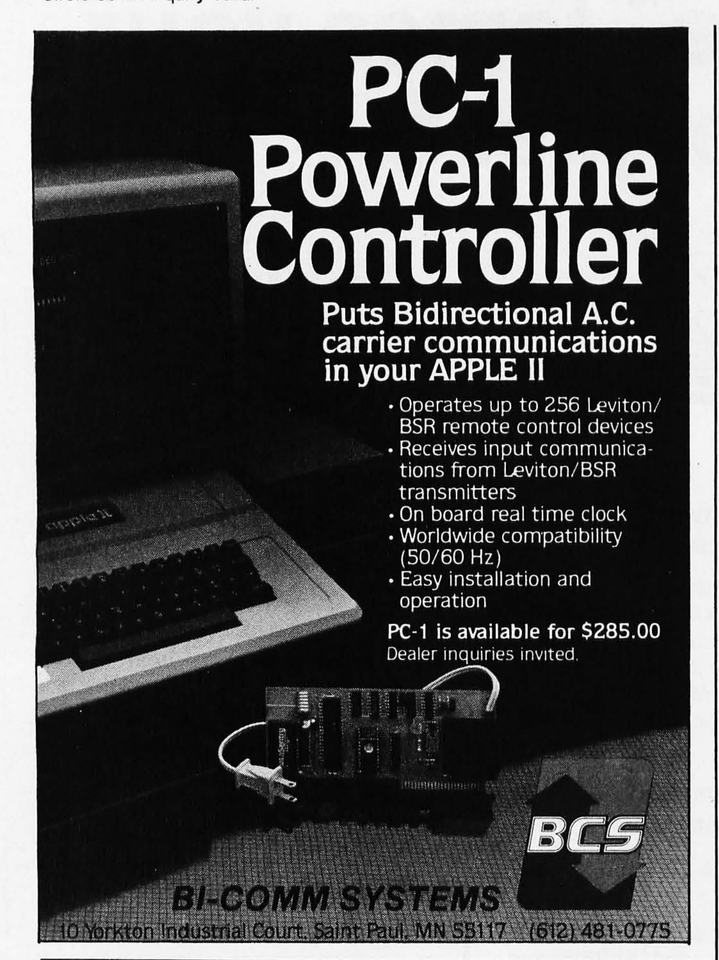
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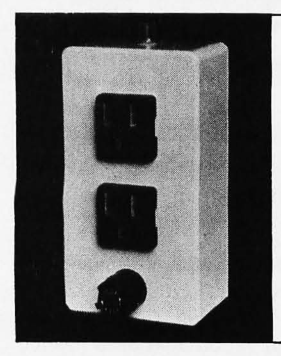
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Window Manager Functions

ClrWndow	Clears the current window, leaving cursor in upper left corner
CreWndow	Allows creation of windows on the video display
DelWndow	Deletes the current window
Exit	Returns to previous menu
Help	Produces a help message for any function label
LdDispCh	Loads character set and assigns to display
LdKybdCh	Loads character set and assigns to keyboard
RevBkgnd	Reverses background color of current window
ScrlMode	Allows text to be scrolled by line or page
SelWndow	Assigns one window as the current window
TestPtrn	Displays test pattern on screen

System Manager Functions

AsgnDrvr	Assigns a peripheral driver to a logical device
DrvrVrsn	Displays attributes of currently available drivers
EdChrSet	Allows user to create or alter character sets
Exit	Returns to previous menu
Help	Produces a help message for any function label
SetDate	Sets the system calendar
SetPrntr	Assigns printer characteristics
SetTime	Sets the system clock

Table 3: *The Window Manager and System Manager menus allow you to choose from a variety of functions.*

turn on the Concept, your current or active volume is System (named /CCSYS), and you use the File Manager option to make any other volume your current volume (see table 2).

Using the Window Manager option, you can create, manipulate, and display up to 17 windows on the Concept's screen. The user moves, clears, scrolls, and deletes windows, which are limited only by their rectangular shape and their need to fit within the Concept's display. Various utility programs available from the System Manager menu allow you to select the I/O drivers, specify printing parameters, and edit the character set. In addition, other utilities let you format floppy disks, automatically load a floppy disk, and execute a printer spooler. The Concept's printer spooler lets you send output to a special volume named /PIPES, and when the network's printer is available, that stored output is printed (see table 3).

When you decide to run a program, the EdWord text editor may be your first stop. If it weren't for its Undo and Redo features, EdWord would be just another unremarkable text editor (see photo 5). The service provided by this combination of features is essentially a "flight recording" of your editing progress. If you blunder and delete a hefty section of an important report, the Undo feature restores the text to its preedited condition.

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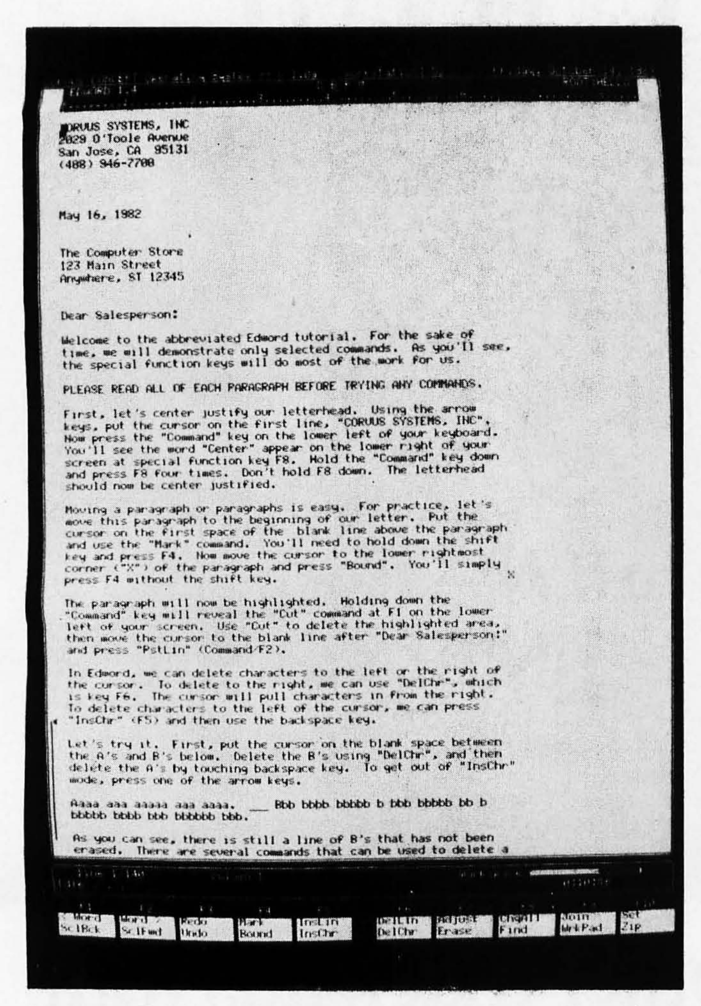


Photo 5: *The EdWord text editor can display more than 60 lines of text on the screen. Note the thermometer-like workspace indicator (bottom right) and the cursor/position scale (lower left of text).*

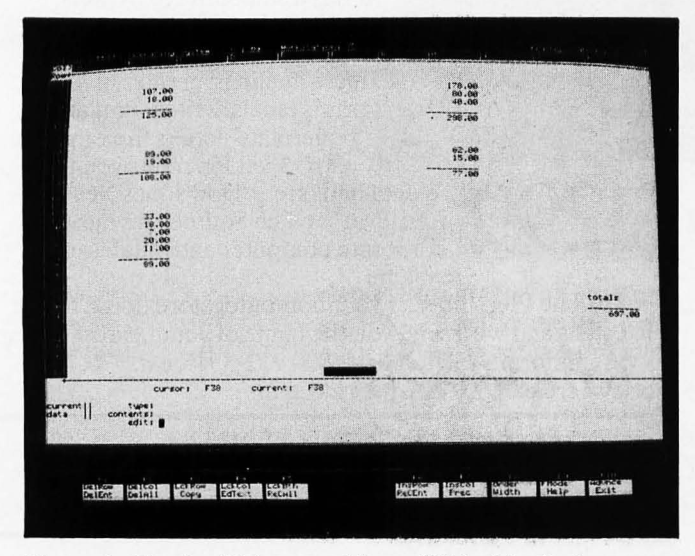


Photo 6: *The LogiCalc spreadsheet. With this display, more than 400 items can be shown simultaneously.*

EdWord operates solely on files residing in its workspace, a special area of a disk volume that you create. Several files or workpads must be included in this area. These workpads include the text file you are editing, a formatted print file (if you intend to print the text), files for the Undo and Redo information, copy space for your cut-and-paste operations, and a directory of this workspace. The smallest allowable workspace is 50 blocks (512 characters to a block) with the upper limit determined by the size of the volume containing the workspace.

Several important and variable editing parameters are displayed with graphics. A column rule indicating the width of the editing window tops the EdWord display. At the bottom of the screen is a thermometer-like scale that reveals the proportion of the workspace that is free. Another linear scale in the lower left of the screen displays the cursor's present position within the document being edited. In addition to these graphics representations, the system also shows the actual line number, column number, and number of lines in the text at the bottom of the display screen.

One advantage that EdWord provides over most present editors is the ability to execute system functions without exiting to the operating system. If you want a directory of available files, you simply request it from within the editor.

LogiCalc

A chronic problem of most spreadsheet programs is the limited size of the video display. The Concept solves this problem by allowing you to rotate the monitor 90 degrees, displaying a spreadsheet with 38 lines and 10 cells of 12 characters (see photo 6). With more than 500K bytes of memory available, a LogiCalc model might contain 1000 active cells. Like EdWord, LogiCalc provides the expected functions and a few pleasant surprises. The expected functions involve cursor control and data entry. The surprises are more sophisticated, presenting the user with a calculator, linear-regression functions, formatting commands, averaging and summation functions, and even user-definable functions. Although these are not unheard of in spreadsheets, it's rare to find them all in one program (see table 4).

Development Tools

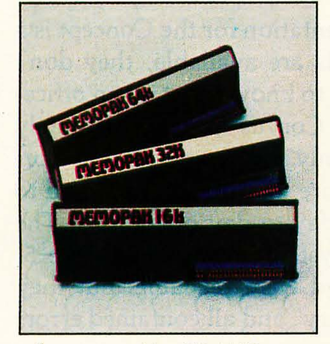
Even with a text editor and spreadsheet, an obvious lack of business-applications software still limits the Concept. In particular, database-management programs and graphics and accounting packages will be necessary before this machine can take an active role in the office. Corvus is taking steps to encourage the development of more software by providing Pascal, FORTRAN-77, a 68000 assembler, and a CP/M emulator. It is hoped that this step will promote program development by software houses.

Corvus Pascal, developed by Silicon Valley Software, is compatible with the ISO (International Organization for Standardization) Level 0 standard and provides most

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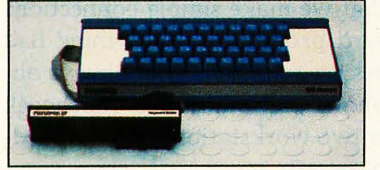
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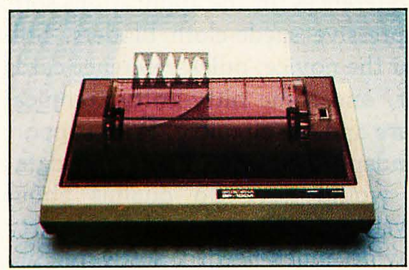


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LogiCalc Functions

Advance	Automatic cursor advance during text entry
ACalc	Automatic recalculation of whole spreadsheet whenever an item is entered
Aform	Begins text entry on a predefined form template
Copy	Copies series of entries to another part of the sheet
DelAll	Erases every entry
DelCol	Erases a whole column
DelEnt	Erases a single entry
DelRow	Erases a whole row
EdText	Allows editing of items on the entry line
Exit	Returns to previous menu
FMode	Selects form mode
Go To	Moves cursor to a specific entry
Help	Produces a help message for any function label
InsCol	Inserts a new column into the array
InsRow	Inserts a new row into the array
LckBth	Allows simultaneous viewing of two parts of the sheet
LckCol	Allows simultaneous viewing of two parts of the sheet
LckRow	Allows simultaneous viewing of two parts of the sheet
Load	Reads a disk file into the array
LstVol	Lists all files of a volume
Merge	Overlays a disk file onto the current array
MovArr	Positions the cursor at the top left entry
NxtRow	Moves cursor to first item of next row
Order	Changes the order in which the array is evaluated
Prec	Sets the number of decimal places to be displayed at any entry
Print	Prints copy of spreadsheet
ReCAll	Recalculates results at every position
ReCEnt	Recalculates results at one position
Save	Writes array to a disk file
Space	Displays space available
Where?	Gives coordinates of cursor position
Width	Sets cell width

Table 4: *The LogiCalc functions include all the expected ones plus a few surprises.*

UCSD features as extensions. A run-time library provides a source of relocatable support code. Any compiled Pascal source file must be linked with this library before the system produces executable 68000 object code. The same developer provides the FORTRAN-77 compiler that conforms to the ANSI (American National Standards Institute) standard. As with the Pascal, this compiler's output must be linked to a run-time library before execution.

The Corvus ASM68K assembler is quite similar to Motorola's specifications syntax for 68000 assemblers, and its output is also relocatable object code that must be linked to a run-time library. The CP/M emulator makes the Concept actually emulate the registers and instructions of an Intel 8080 microprocessor. Programs written for the 8080 can thus be transferred and run on the Concept. Obviously, for anyone who has already invested in 8080 software, this feature is important. Unfortunately, because Corvus doesn't emulate instructions for Zilog's Z80 microprocessor, Z80 specific code will not run under the CP/M emulator.

All the built-in CP/M commands are available, as well as the transient commands: ASM, DDT, DUMP, ED, LOAD, PIP, STAT, SUBMIT, SYSGEN, and XSUB. Because of the software overhead, however, the emulator runs slower than the average CP/M system. In the emulation mode, the Concept provides access to as large a quantity of hard-disk storage space as the user wants. In fact, you can assign 16 CP/M logical-disk drives to the mass-storage volumes. By adding the optional 8-inch floppy-disk drive, the Concept can also read standard IBM 3740-format single-density disks. When you use the emulator, the screen and keyboard appear to CP/M as a Lear Siegler ADM 3A video terminal.

Documentation

Bluntly, the lack of documentation for the Concept is a tragedy. While some manuals are available, they don't begin to cover what you need to know to set up an office-automation system, and the Corvus Concept definitely falls into that category. The only saving grace is that Corvus worked very hard to ensure that users won't need to refer to the manuals during day-to-day operations. The manuals supplied with the system are listed in table 5. Most of the ones we received were readable, but they were also stamped "Preliminary" and all contained errors and confusing passages.

Conspicuous by its absence is an introductory manual providing an overall view of the Concept. The user needs to know what to expect from this system, how to set it up, and something about the philosophy behind the system design. Although installing the system and getting it to run required only that we make simple connections and follow straightforward procedures, everything had to be done in the right order— which was not always obvious. After a dozen phone calls during a four-week period, we finally got our two workstations and the hard-disk drive with a video-cassette-recorder backup communicating over the network.

Considering that the Concept is aimed at the business market, Corvus should make the installation as fast and painless as possible. A big step in that direction would be an improved set of manuals. The current materials are primarily a set of dry references for the applications software packaged in impressive suede-cloth binders. Still lacking are tutorials for the novice, quick-reference cards for the advanced user, and some nitty-gritty technical manuals on the software and the circuitry. With support materials like these, independent consultants and data-processing managers would have no qualms about recommending this system to clients, and third-party developers could provide much-needed software and add-on boards.

Performance

While user-friendliness is an important consideration, the Concept must also be able to work for a living. The machine's particular combination of features—graphics potential, powerful processor, large memory, FOR-

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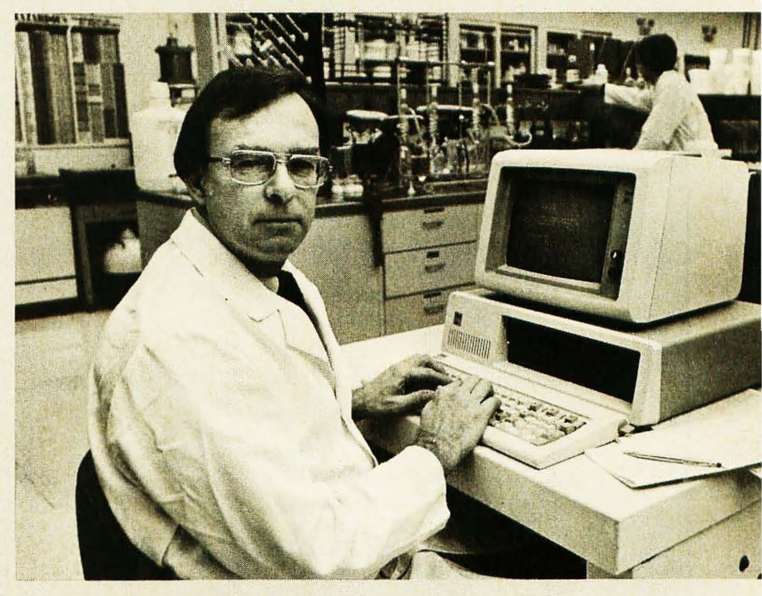
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Outline of Corvus Manuals

Manual	Pages
Personal Workstation User Guide	(120 pages)
System Start-up	
Keyboard and Display	
Operating System	
Utilities	
Peripheral Connections	
Omninet Disk Installation Guide	(41 pages)
Hardware and Software Required	
Hardware Setup	
Booting from Disk	
Firmware Update	
Disk Initialization	
Booting from the Network	
Copying System Files to Hard Disk	
Operating System Reference Manual	
File System and Volumes	
Operating System Interface	
Utility Software	
Software Development Tools	
Linker and Librarian	
Drivers	
LogiCalc Glossary	(142 pages)
Function Key Labels	
The System Functions	
The Calculator Functions	
The Linear-Regression Functions	
The Slash Commands	
Miscellaneous Functions	
The User-Defined Functions	
Conditional Expressions	
EdWord User Guide	(133 pages)
Overview	
The EdWord Workspace	
Making a TXT Workpad	
Basic Editing	
Formatting Text	
Printing a Workpad	
Dot Commands and Codes	
Search and Replace	
Cut and Paste	
CP/M Emulator Installation Guide	(20 pages)
Installing CP/M	
CP/M on the Concept	
Technical Notes	
FORTRAN Language Reference Manual	(171 pages)
Introduction	
Lines, Statements, and Control Flow	
Data Types and Constants	
FORTRAN Names, Arrays, and Substrings	
Expressions	
Specifications Statements	
Data Initialization	
Assignment Statements	
Control Statements	
FORTRAN Input and Output	
Units	
Format Specifications	
Program and Subprogram Structure	
Using the FORTRAN Compiler	
Pascal Reference Manual	
Introduction	
Defining Data Types	
Declaring and Referencing Variables	
Expressions	
Statements	
Input and Output	
Program Structure	
Standard Procedures and Functions	
Running the Pascal Compiler	
Pascal Language Syntax	
Relationship to Other Versions	
Data Representations	
ASMK68 Assembler Reference Manual	(82 pages)
Introduction	
Layout of an Assembler Program	
Operand Information	
Assembler Directives	
Assembler Operation Codes	
Using the Assembler	
Assembler Output and Messages	

Table 5: *Outline of manuals available for the Concept and its attendant software.*

TRAN, and Pascal—makes it attractive to scientists and designers, as well as to the business community. To determine a performance rating of the Concept in a time-sensitive environment, we compiled the Pascal version of Jim Gilbreath's prime Sieve benchmark (see "Eratosthenes Revisited: Once More through the Sieve," January 1983 BYTE, page 283). The compilation was fast, less than 8.2 seconds, with an execution time of 21.26 seconds, slower than the times of most 8-MHz 68000s running Pascal. We also compiled the FORTRAN version of the Sieve with a compilation time of 30 seconds and an execution time of 4.5 seconds—a quite respectable performance.

While multiuser systems always exhibit a loss of response time as more users come on line, this result may not occur with a distributed processing system such as the Concept and Omninet combination. In this case, the only possible waiting occurs when two users try to access the same shared resource, for instance, the hard-disk drive or a printer. We were unable to detect any difference with either one or two active users, even when both were performing tasks involving a high level of disk I/O.

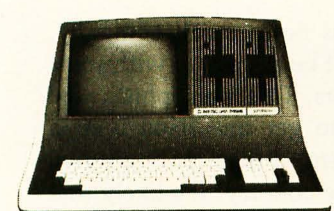
Prices and Options

Today, the Concept does not offer many options. The basic workstation with 256K bytes of memory costs $4995. Another $1000 gets you an additional 256K bytes. Included with the workstation are the operating system, two serial ports, and the built-in Omninet interface. The required hard-disk drive, available from Corvus with capacities of 6, 10, and 20 megabytes, costs an additional $2495 to $4495. You can install the hard-disk drive in an expansion slot, if it is intended for use on a single Concept, and through the Omninet interface, if it is to be shared by more than one workstation.

The only real options are a thin-line 8-inch floppy-disk drive and the Mirror backup unit for the hard-disk drive. The floppy-disk drive, in its own enclosure, connects to an interface board installed in the workstation's expansion slot. The Mirror, which connects between the hard-

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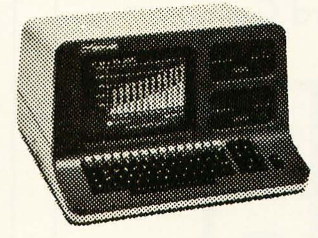
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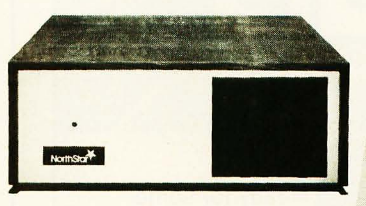
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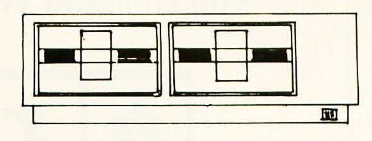
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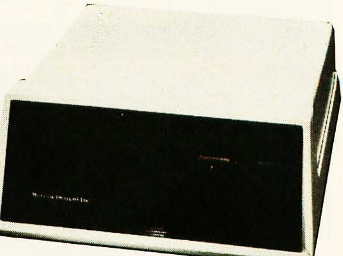


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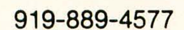
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disk drive and a user-supplied video-cassette recorder, records data on a video cassette. This backup is essential in an office environment where lost data means lost business. The Mirror—which can record 6 megabytes in 11 minutes, 10 megabytes in 17 minutes, and 20 megabytes in 35 minutes—costs $1250.

Service

While Corvus Systems Inc. is not a small company, getting a Concept repaired won't be as easy as with some other popular personal computers. This is a sophisticated machine, and the only place to get one fixed is at a Corvus-authorized dealer. Presently, there are only two dozen of these dealers across the country. It's likely that these dealers will need technical manuals to perform the necessary repairs, and there is also no word yet about the availability of service contracts. This seems to mean that Concept owners are taking a chance if they rely on one machine. With a large networked system, you can usually weather an occasional failure. At this point, I should add that we haven't had any problems in more than 100 hours of use.

The Envelope Please

I approached the Concept with high expectations, which for the most part have been realized. The designers have included some features that are very special. They have created menus for every possible situation. The keyboard and video display should set a standard for mass-produced personal computers. The bundling of a complete package of business software and hardware is also an idea to be imitated. These features make the Concept a highly usable computer system.

I would like to see Corvus attend to a few details. My most nagging concern is with the inconsistencies encountered when you move from level to level in the menus. When you want to return to a parent menu, you must select a function button. Depending on which level you are at, however, that key is labeled Quit, Exit, Edit, Cancel, or (Cncl). One of the advantages of function keys is not having to memorize the commands. With this arrangement, you must still memorize a set of commands for each level. Adding to the confusion is the fact that the same function label has a different result in different menus. For example, in one menu Cancel returns you to the most recent menu; at another level, it returns you all the way back to the first level, the Dispatcher.

I also found a few cases in which a function listed on the screen was not yet implemented, specifically the < Para and Para > functions in EdWord and the print spooler. In only one case did I find an improperly implemented function, which was a minor problem. Overall, Corvus has done many things right in creating the Concept, but the system needs much more applications software to take advantage of its features. Although the manuals seem to be a major stumbling block, if a sufficient number of companies develop programs and boards for this computer, the Concept could still become a very popular machine. ■



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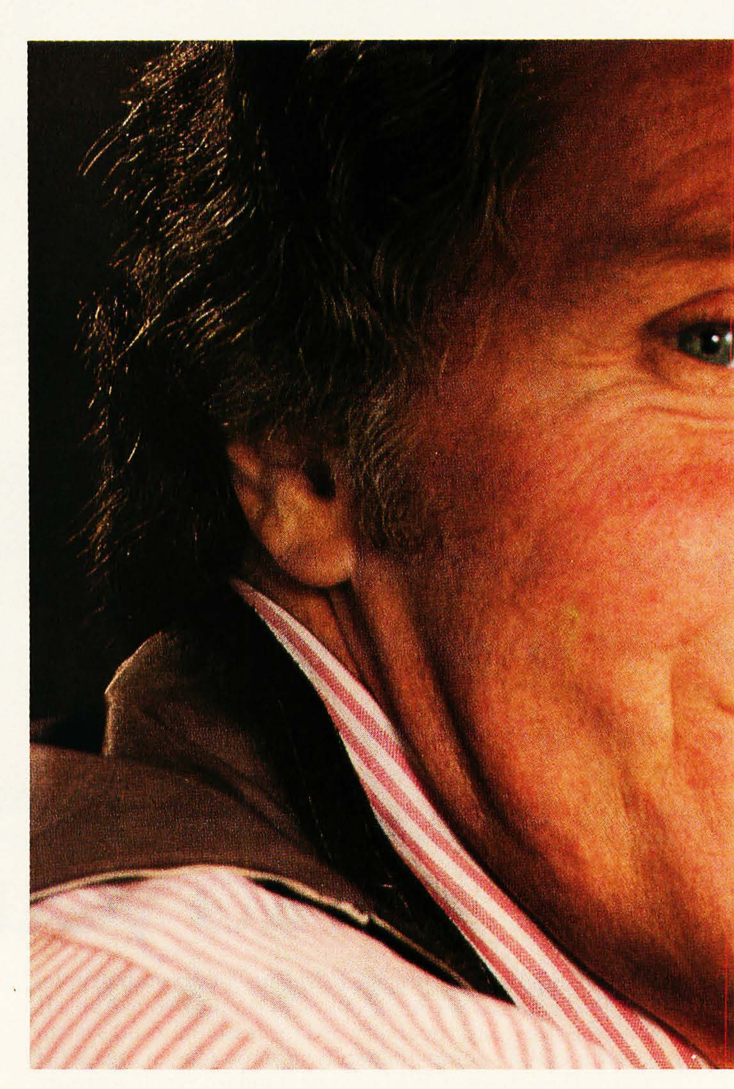
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Randy J. Goldfield
The Omni Group
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The issues of automated office management and white-collar productivity are no longer the stuff for futurists. The spiraling availability of high-technology office equipment, coupled with inescapable economic forces like increasing labor and management costs on the one hand and decreasing costs of electronics and communications on the other, mandate that top management address the issue of how to increase office worker productivity in this new environment.

The trend is clear: improved white-collar productivity has become a key to increased profitability. There is a twofold reason for this: the white-collar work force now accounts for the majority (53 percent) of workers and, simultaneously, past blue-collar productivity gains show little leeway for further improvements. According to Labor Department statistics, while industrial productivity rose 83 percent during the past decade, there was a mere 4 percent advance among white-collar workers, despite huge outlays for new technological equipment. The shift away from an industrial work force to an office work force adds greatly to the importance of automation as well as to the potentials for greater output.

Today, business is on the verge of enormous changes spawned by the development of new technologies for distributed word processing, smart copiers, effective terminal PBXs, computerized filing and data banks, laser printing, and the like. As a result, management is faced with the strategic issue of collectively committing tens of billions of dollars to the new and evolving technology of office automation. Executives are asked to weigh technologies that are often not completely understood, factor them into potentially disruptive human elements, and then decide to what extent they should commit to a relatively new office work-style or mode of operation.

The Two Reactions to Office Technology

There have been two general reactions to the challenge of office technology. Both are extremist and contribute to poor results in automated ventures. The majority trend has been to wait for the emergence of time-proven office systems and technologies that present minimum risk. Unfortunately, this trend often leads to a loss of competitive edge in the marketplace.

The second reaction falls to the breed of executives who, so overly enthralled with new technologies, ignore bottom-line reality. To some degree, the reason that investment to date in advanced office equipment has not paid off in more visible productivity dividends is because this Buck Rogers group—by focusing predominantly on equipment at the expense of integrating advances into office procedures and human factors re-

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About the Author

Randy J. Goldfield is president of The Omni Group, a New York-based consulting firm that specializes in office systems productivity improvement.

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quirements—often created overly ambitious projects that were never completed or disappointed users or caused fiascoes when employees refused to adapt to change.

Of course, almost everyone knows cases where high-technology equipment was installed and failed to live up to expectations. Responsible management, however, recognizes that the office has become the next logical place to look for the sort of improvement that can mean sharply increased profits. In fact, with office overhead costs now accounting for 52 percent of operating costs (up 100 percent since 1955), improving productivity in the office has become imperative. What, then, are the key issues to determine before creating a corporate office automation strategic plan? And what are the results that can realistically be expected? These questions must be addressed before any successful implementation can be accomplished.

American industry invests enormous amounts of capital in its workers—and is growing rapidly as the U.S. economy evolves from primarily a manufacturing base to a service base economy. The federal government predicts that by 1985 about 55 million workers of the projected 104 million person work force will be working in offices. For a national economy that historically has had a farming and manufacturing base, this is a revolution indeed. The Commerce Department estimates that some 60 percent of the gross national product already involves information production, storage, transfer, and utilization—clear evidence that the Information Age is already well upon us.

A recent analysis of current and projected work force costs for more than a dozen companies conducted by Gibbs Consulting Group shows they spend record amounts in direct costs for white-collar workers and for information resources/access in an attempt to reap greater gains in worker output. And this is clearly the trend. Melody Johnson, of Kidder Peabody, explains, "Everyone seems to be jumping into automation! Unfortunately, not everyone is prepared to deal with the problems, and consequently not all will reap the benefits."

Because, despite these expenditures, most office workers are far from being as productive as they can be. In a recent Lou Harris poll conducted for Steelcase, between 67 and 80 percent of white-collar workers reported their individual productivity could be increased if the office work load were reorganized and analyzed so work flowed more smoothly from person to person and department to department. In fact, almost all executives surveyed said they backed investment in more computer terminals and electronic filing, typing, copying, and other equipment to increase office efficiency.

Business executives give top rankings to conversion to electronic-processing telecommunications and data-processing methods as these offer the most visible productivity gains. In addition, the need to enhance overall functioning, and the need to seek better physical layouts that would positively affect employee productivity, play important roles in the reorganization and refining of the office environment.

Despite the investment in labor and the clearly perceived need for productivity increases, the total investment in information resources has reached only about $73 billion, which, impressive as it might seem, does not clear the threshold necessary for meaningful productivity improvement. In a recent survey of professional productivity, it was determined that professional staff interfaces with computers less than 1 percent of the time. Pens and pencils, at 65 percent, were by far the most popular tool. Overall, it is clear that integrated systems with their synergistic effect on productivity have not yet been put into the right place in significant numbers.

The Spread of Automation: The Rationale

Of course, many current office systems have at least some equipment that can help boost output. Although U.S. business is generally still entrenched in inefficient paper, mail, and filing systems and relies on anti-





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quated typing equipment and "dumb" copiers, there also are electronic data-processing machines, leased or owned private branch exchanges or key systems, and increasing numbers of basic word processors (mainly standalone, single systems). And these devices can, and do, improve productivity. But productivity improvement is not always the only issue. In fact, productivity increases when not offset by staff reduction or cost avoidance will not benefit the organization. And it takes careful control to ensure the savings are captured.

It is estimated that U.S. business can anticipate a productivity and cost reduction of about $300 billion annually by 1990, simply by adapting new technology and focusing work forces in the right direction. Jack Walsh, Director of Information Services at Avon Products, feels that productivity is a secondary consideration. He says, "Most managements are concerned with profitability. Those of us in the trenches, who understand the day-to-day needs of coordinating human resources, machinery, procedures, etc., see productivity as a realistic goal, but senior management will lean toward profitability. Until our offices mature, the profitability of installing automated equipment will overshadow productivity issues."

In addition to productivity improvement and profitability concerns, an added benefit of automation is to allow top management to make far faster, higher-quality decisions because of the new systems' capabilities for organizing, sorting, and storing huge amounts of data at speeds measured faster than ever thought possible. And, in fact, other "soft" benefits, such as improved customer service, faster research and development, better marketing information, etc., are all outgrowths of office automation.

Therefore, the executive charged with determining policy on automation must understand both hard and soft improvement opportunities and pressures and the three basic rationales for conversion.

Improving Corporate Profits. Current competitive patterns and seemingly intractable lags in productivity make this a persuasive argument for automation. The significance to a company's competitive position, of course, varies with the industry. In banking and insurance, for instance, automation is a critical issue. But at some point in the next 5 to 7 years it is clear that automation will be a necessity that is driven equally by increasing overhead and more automated competition.

For example, some banks have increased their market share by taking greater advantage of information technology to provide 24-hour banking and instant access to customer records. This strategy stems from the highly competitive environment of banking. Similarly, legal firms use terminals to query court proceedings and other legal information as a counter to the growing volume and complexity of precedent searches. In helping to achieve these goals, office automation becomes a strategic issue as well as an operating decision.

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ventional office support systems are not only outdated, but inefficient. Labor-intensive jobs like secretarial typing, shorthand, etc. can be greatly reduced or eliminated by automation. In addition, potential staff reductions through improved processing by machinery can often reduce the number of employees required to perform the more redundant tasks.

Increasing Professional Productivity. In the average company, professional salaries account for about half of total salary costs. As the largest segment of the work force salary, increased professional productivity becomes a prime target and justification for automation and increased output. An outlay for equipment, therefore, can be recouped very quickly. Although difficult to quantify, the benefit of providing complete and correct data to professionals is, perhaps, the greatest profit improver office automation will offer. According to James Folts, Vice President, Corporate Development at Syntrex Incorporated, "Automation as a management tool is the single most important factor in office automation. Historically, management has viewed office automation as a secretarial tool. However, this approach is the least cost-effective. When used as a professional tool, automation can have an impact on productivity for outweighing the simple increases in document production many companies see as the chief benefit of automation systems."

While word processing and data processing have initially focused on clerical and secretarial staff, increased professional productivity is now seen as a major priority in business. Professional staff salaries have the greatest impact on white-collar costs because much of professional work can be defined as decision making. The key factors in improving productivity are timely handling and processing of information and a reasonable amount of information upon which to base decisions. When people don't have the correct information resources, decision making becomes more complex, and usually less effective. Conversely, if you inundate people with facts, details, and ideas, they are unable to effectively analyze this profusion of information and the right decisions will become impossible to make. The crux is that the proper amount of information provided in a timely fashion permits reasonable decisions. A chief objective within the office, therefore, is to provide professionals with reasonable tools that give them the information they need to make practical, timely decisions. Information must also be presented in a useful form and automation enhances the availability of information. Hence, the obvious relationship between decision making and automation.

Taking the Plunge: The Risks of Converting

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profitable automation will be forthcoming from research and development groups working at beta test sites across the country, and the fear of becoming involved in automation too early, or of being locked into obsolete equipment, should be put into its proper perspective. A timely start, despite the hazards involved, will ensure a smoother transition, as automation makes further advances, along with the development of a core of internal expertise that can provide hands-on knowledge and a leading edge on the competition.

But this does not mean that one should opt for an overnight plunge into the so-called, much-touted "office of the future." Because most offices exist with yesterday's systems (or lack of them), an orderly update to the "office of today" makes more sense and avoids the trauma, expense, and serious disruptions that an overly ambitious or, perhaps, premature program will invariably cause.

Of course, outright purchase of equipment in a climate so volatile is rarely desirable, although some underfinanced manufacturers make their rentals virtually punitive versus relatively attractive lease/purchase plans. The cash flow and capital situation of the company is, of course, also a factor. In fact, cost-justification and return on investment become highly complex.

Quantifying Benefits: Justifying the Investments

There is, typically, a "backbone" application that must exist to justify automated equipment within each area of a company. Frequently, that backbone is word processing—the task of text-editing and manipulating words—where productivity can be dramatically increased by automation with the least outlay of capital and most quantifiable resultant savings. In promoting a recently announced multipurpose office system, for example, salespeople stressed its application simply by cost-justifying it as an automatic typewriter. Despite many other capabilities, products from Xerox, Syntrex, IBM, and Wang are also marketed in this manner to capture the most obvious audience. Chuck DeNapoli, General Sales Manager at Micom, explains, "Our marketing approach is to appeal to the clients' common ground, and then augment it. New accounts usually feel more comfortable approaching advanced automation applications as an add-on to their current typing process rather than a completely new and different mode of operation. Improved typing is often the best avenue to travel on first applications."

But once a terminal is in place for word processing, additional peripherals can add sex appeal and accrue additional benefits for very little or no extra cost. Applications like automatic filing, conferencing, or electronic mail can complement the backbone application.

Electronic mail alone, for instance, is rarely cost-justifiable except in unique situations requiring both speed and accuracy. But without a large installed base of preexisting terminals as a backbone, it realistically is both prohibitive in cost and in usefulness.

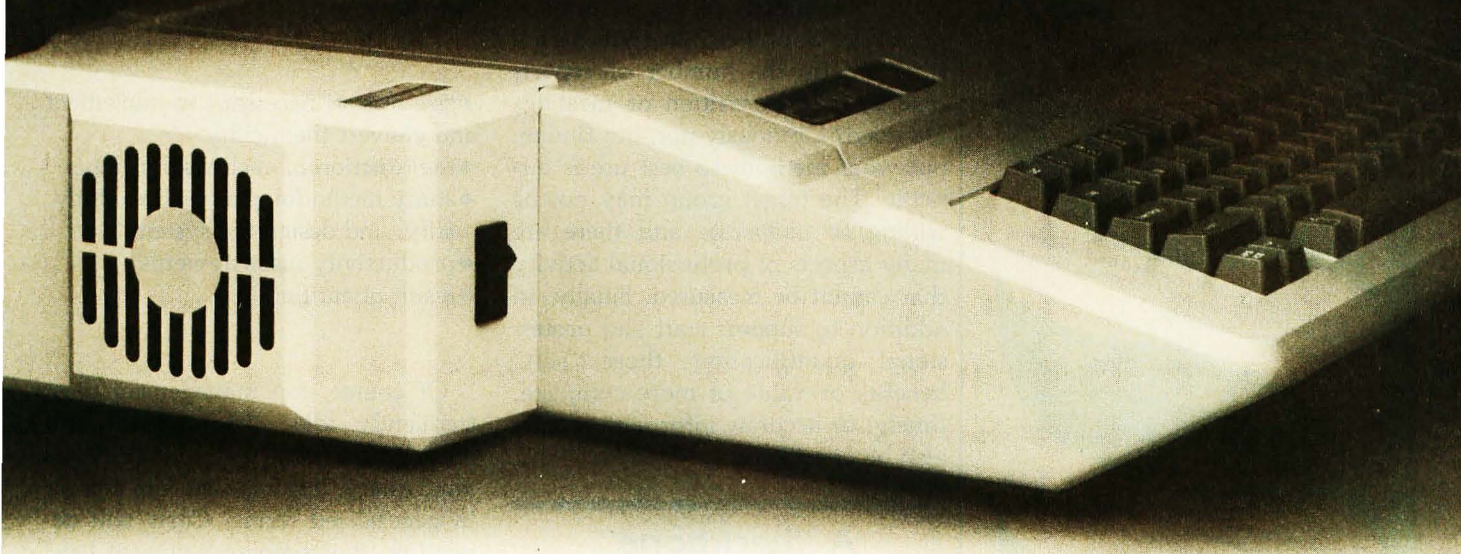
Another key issue is to determine to what extent potential and achieved benefits can be quantified. By and large, the task of quantifying clerical work has been accomplished through systems as sophisticated as MTM and other industrial engineering techniques. Secretarial productivity, however, is somewhat more ephemeral. If a secretary received 20 calls today, versus 40 yesterday, is she half as productive? Clearly, the task is more complex because, in addition to measuring output, a value must be placed on it. Yet administrative support audits can—and do—quantify secretarial efficiency, typically finding cost reduction opportunities of about 20 percent in most studies.

If secretarial productivity quantification is somewhat difficult, it's a cinch compared to the issue of quantifying professional and managerial productivity, which raises far more questions as to its value or its feasibility.

The difficulty, of course, is in assigning a dollar value to creative and intangible activities that may or may not eventually result in tangible

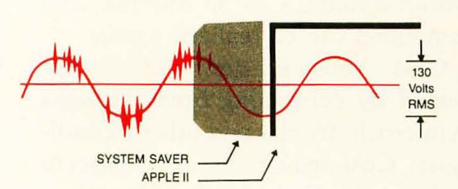
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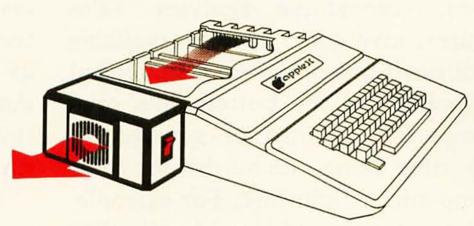


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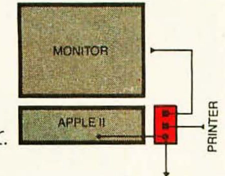
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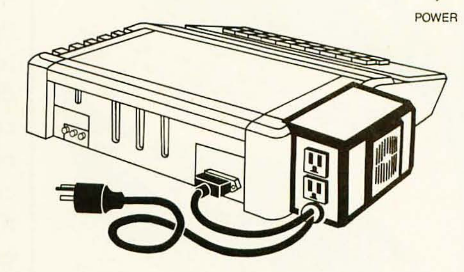


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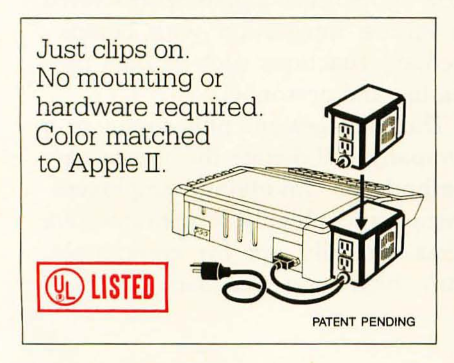
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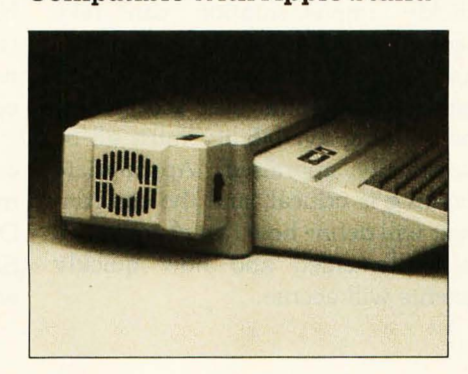


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benefits to the company. Is a trip to a convention productive? By what standard? How do the hours spent preparing for an internal meeting contribute directly to the bottom line of profits? Should productivity be determined by the number of reports read or memos written or meetings attended? Obviously not, but finding out what methods to best use is difficult. The target group may not be willing to cooperate and there are many aspects of professional activity that cannot be measured. Finally, in addition to support staff and professional quantification, those "soft" benefits or value of more complete, timely, or accurate information must also be considered.

A "backbone" application must exist to justify automated equipment within each area of a company.

For example, putting a price tag on the speed and accuracy with which market data, government regulations, competitive analyses, sales figures, inventory, etc. are available is difficult but can make a significant difference on the bottom line of a company. In terms of government reporting alone, the burden for some companies is immense. For example, a report released in March 1979 estimated that *each* of the 48 largest U.S. companies spent an average of $54 million annually on government reporting.

However, implementation cannot begin, even after benefits have been established and costs justified, without careful consideration of how quickly implementation can take place within a particular company's individual environment. Its resources, potential user acceptance, and funding availability must all be realistically appraised. Appropriate planning is critical, and the environment will define how fast changes can be implemented and how quickly benefits will accrue.

Managing Change in the Office

The mechanics of managing office automation present another side to the environment issue. In putting together a plan, one must determine:

- size of staff necessary to implement and convert the facility
- the function of each staff member
- study methodologies used to study, justify, and design the system
- productivity measurements
- result quantifiers

Of course, top management most frequently asks: "How much will automation cost?" Although this is a valid query, it is impossible to answer in generalized terms. Costs will depend on the company's current level of automation, the industry, and individual needs and must reflect them. As a general rule of thumb, hardware costs should be offset by labor savings and productivity increases within about 18 to 36 months, and sometimes can be realized sooner.

Cost considerations are being helped by continuing breakthroughs in microelectronics and other technologies. Cost reductions of 85 percent and more are being realized, and further reductions are certain to appear as the volume of production of automated office equipment continues to run counter to general inflationary trends.

If an implementation plan is being created, it is important to also determine the best way to integrate the plan to a corporation's internal attitudes. Should a task force or committee be set up to assist in the planning and conversion process? What involvement should end users have? Who in the firm should take on day-to-day operational responsibilities? How should such a plan be structured to ensure integration with complementary functions such as data processing and personnel?

The management philosophy of a company will dictate the appropriate method of involving employees. Democratic, highly communicative firms typically opt for committees, with high user feedback and re-

sponse, while more paternalistic firms, predictably, design a system and only then *introduce* it to the staff.

Analysis of individual office styles is also important. What works in New York may not work in Boston, but almost certainly will be totally inappropriate in Los Angeles or Honolulu.

The type of industry is also important. The style of a large nonprofit theater corporation will vary widely from a light manufacturing facility. Careful consideration of the organizational and management philosophy and style will prevent the formulation of a heavy-handed or inappropriate action plan and greatly support active gains in implementation. Of course, risk factors will vary, not only from company to company, but from division to division, or even from department to department. They may include issues such as impact on unionization, loss of professional and clerical staff, trauma during conversion, disruption of schedules, changes in pay scales, or even sabotage to equipment.

It is best to define and realistically consider these risks versus the opportunities, and once a decision has been reached, to proceed, setting up implementation programs to mitigate the risk factors whenever possible.

To lessen some of these risks, begin automation slowly. Installing a "core" system to provide one department or office with several applications is a good approach, with dispersed or satellite equipment of a more limited but compatible type in other parts of the company. In this way, the overall corporate structure is introduced to the benefits of automation on an incremental basis.

Such basic systems should be capable of relatively simple expansion, as more and more of the firm's information and transactions are switched from paper to electronic media as development of the system proceeds. This sort of solution, if the original equipment is planned as cost-efficient from the beginning, can also ease financing problems that may extend beyond cash flow and debt considerations. Programs that are demonstrably self-liquidating can go far toward convincing boards of directors and activist stockholders of the viability of new technologies.

Picking the Hardware: Defining the Function

The concern that is raised with greatest frequency by users at professional conferences, seminars, and on consulting assignments is always: "What equipment should we be using in automating our office?" Unfortunately, the push from zealous vendors has focused attention on equipment, and all too often users are made to believe that it is the machine rather than the procedures that is the key to a successful conversion. Management is also intimidated by the technology and fearful of making a wrong choice.

Publicity and media overexposure, coupled with a host of manufacturers jumping into this hot marketplace, have inevitably led to confusion over the viability of the "office of the future." But when you define office automation needs by *function*, rather than with a hardware bias, equipment falls relatively easily into five basic functional categories.

Of course, equipment will vary considerably and continue to do so, but can best be judged by the components most systems use and then individually compared.

Input. This converts information from the human-recognizable form of the typed page to electronic storage form, for example, the keyboard on a word processor is the input component through which an operator translates a handwritten draft into impulses on magnetic media.

Output. The component that performs the reconversion translating from electronic/storageable form to human-recognizable form, e.g., laser printers that translate magnetic coding into typewriter-quality, human-readable documents.

Storage. The electrical, magnetic, and optical filing of information that can be done on microfilm or microfiche, computer disk, cassette, magnetic card, or other media, both on line or off. These media have the unique ability to conserve space by thousands of percentages.

Transport. The transfer of information either electromagnetically or optically between devices, as in OCR scanning or facsimile transmission.

Processing. The capability to perform logical arithmetic or formatting manipulation of information, as well as the control of all four previous physical components through software procedures.

By determining the requirements of a particular office, one can select the category of functions that need to be fulfilled and judge available equipment by the quality and features of the components that fulfill these functions. The old hardware categorizations, such as "stand-alone word processor" or "executive terminal," are not really relevant. To be sure, to best address business needs, the process must involve defining current support requirements and potential benefits of automation, designing the appropriate systems, and estimating resource requirements to achieve the plans.

Some firms have even created a position to address this need, such as Director of Office Automation, Vice President of Productivity, etc. Although the titles vary, and the responsibilities range from simple advisory to wholesale implementation and management duties, the position is, in almost all cases, that of a company-wide coordination ensuring an integrated and compatible approach to office automation.

This sort of approach requires a management commitment to change. And although no totally futuristic or empirically more productive automated office exists in today's business place, beta test sites and partial conversions are springing up nationwide. Many have been instigated by relocation projects—company moves are a perfect opportunity for reevaluation and change.

Converting the Office: A Blueprint for Change

Planning and bringing to successful completion a conversion to office automation must successfully address all the issues already described. The approach suggested below can assist in ensuring success, but the solution,

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of course, must vary depending upon the unique needs of the situation. The *outline below* helps make sure that all aspects of office automation strategic planning are covered, but, realistically, the skill of a Houdini still may be needed to pull it off.

Step 1. Create a detailed work plan for the project. Because of the implications and tremendous breadth of an undertaking like this, a fully detailed, time-phased plan is necessary to describe tasks that must be undertaken, manpower necessary, elapsed time for each task, and target due dates, which may extend over a period of years. Such a plan will help control an unwieldy, major undertaking. Most important, the plan should be approved by top management before the program begins, which guarantees its knowledge of and involvement in various steps. Interface with office corporate groups is also necessary to ensure compatibility in planning between sites.

Step 2. Assess business needs and relate them to automation/productivity implications and opportunities. Those involved in designing automated systems must understand the future business directions and strategies of the corporation and compare the operating objectives, long-term positioning, and economic and regulatory constraints to available technological solutions. For instance, rapid growth, industry needs, competitors' capabilities, and even the overall economy are important considerations when designing a system. Governmental policies, new business strategies, cash flow, or changing marketplace conditions all should impact the plan.

Because of the certainty that meaningful office automation will vastly affect both day-to-day operations and strategic outlook for the enterprise, rigid analysis of where the company is and where it intends to go is essential. When the planning process is ended, if it is successful, the firm will commit itself to a phased implementation program that will merge downstream with the company's evolving business and market strategies to capture potential productivity gains.

Step 3. Select applications and concepts that will profit and improve business. By applying the set of available automated office concepts to business needs, a backbone application as well as additional peripheral applications should evolve.

It is critical, then, that the benefits of technology *specific to industry and business* be determined. For example, electronic mail is most attractive when *internal* communications need enhancement. For a firm with largely external communications needs, electronic mail will not be a great boon. It is the role of the office automation practitioner to overlay the business needs onto the available technology, determining applications.

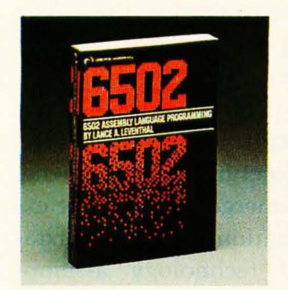
Armed with what amounts to a first-cut solution, the planners must then determine resource requirements to bring about such a solution. Financial and personnel needs must be weighed carefully and then factored in with a prudent estimate of what future technical, human, and financial resources the company can commit. Without an assessment of the "real" constraints as perceived by future end users, office automation planners may find themselves in a situation where "client" departments are very resistant to change and feel left out of the planning process involved. Needless to say, "solutions" presented without first going through this feedback loop are doomed to failure.

Step 4. Conceptualize the architecture of the system. The user must develop a conceptual design of the proposed system based on available technology, price/performance, and vendor service and support records. Systems architecture must be described in terms of the five physical elements previously mentioned: Input, Output, Storage, Transport, and Processing.

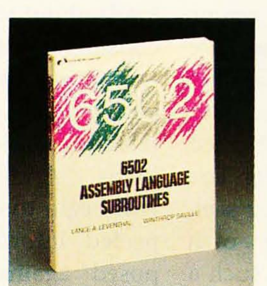
At this point, organizational alternatives must be considered. Should devices be located in centers, in clusters, or individually? Should they

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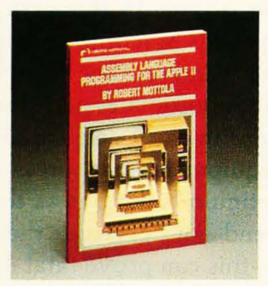
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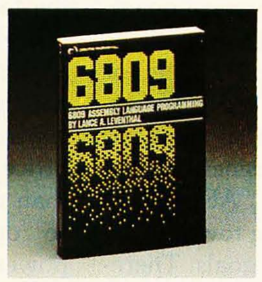
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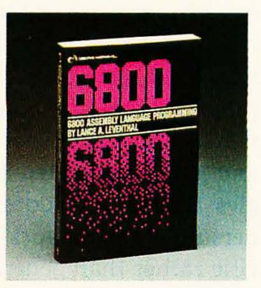
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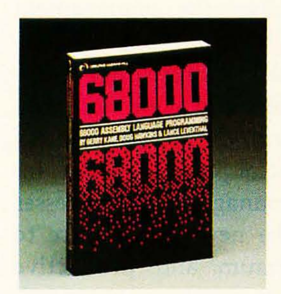
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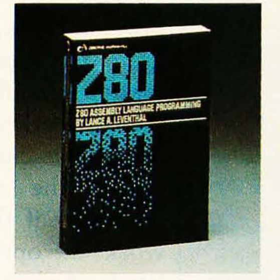
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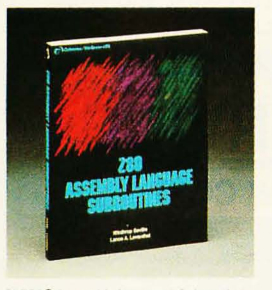
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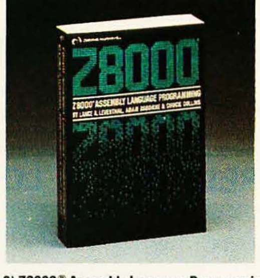
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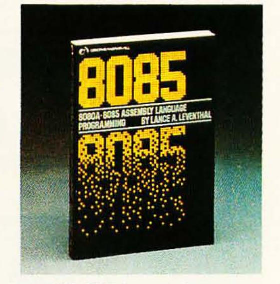
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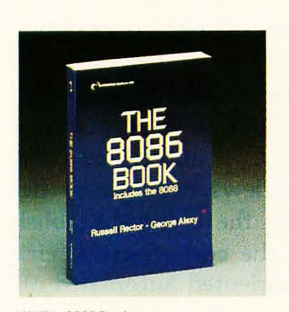
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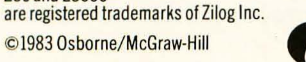
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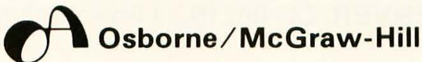
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be used by dedicated full-time operators or by multifunction personnel? Should devices be located at the professional workstation, by secretaries, or perhaps only one should be assigned within a department?

Often, enormous flexibility can be achieved through the use of distributed information systems, which sometimes permit equipment to be located at great distances from the main computer.

During rapidly changing business conditions when inventory control is especially crucial, this sort of option can have enormous economic impact. As architecture falls into place, planners need to establish a system of priorities that combines the predetermined criteria for potential solutions and the interrelated business strategies they must address. Also, planners must begin working toward specific rather than general goals. Therefore, it is important that past work and estimates of future needs be checked for accuracy.

Step 5. Define and address human resource issues. The reaction of the end user to automated office support systems must be considered, including behaviorism; staff orientation, training, and preparation; and habit changes. In fact, it is the people problems that are perhaps the most difficult issues to resolve.

New positions, new tools, and new roles for office staff are bound to create fear and concern among office workers. Job security status and salary issues will need to be addressed. In addition, human resources to undertake the physical conversion must be located and allocated to the tasks ahead. In this area, senior office systems practitioners must take a strong hand during the planning process. Subordinates and those with experience in early, less sophisticated office equipment may press for less than optimum solutions as they seek to defend or enlarge their own power—this can prove fatal in such a venture.

Senior office automation practitioners must consider whether current staff with expertise in the fields of data processing and word processing, telecommunications, and the like have the abilities to move into crucial management roles in the new office structure. Often, new technologies involve massive and potentially dangerous change, and top management should view the decisions made on the issues of supervision, reporting, and authority levels to be as important as they would be when establishing a new division upon which the firm places major hopes for future profitability.

Step 6. Select appropriate hardware. Basic assumptions must now be made about the equipment itself. Key considerations are availability, level of support, price flexibility, and the performance of hardware, software, telecommunications, and related items. Architectural requirements will begin to emerge as the list of expected information flows is juxtaposed against technology assumptions. Negotiations with vendors must begin, equipment must be selected and displayed, and operating staff must be trained.

Step 7. Design the management process cycle. With a workable program for implementing office automation, planners still have not completed work on critical issues. An especially crucial consideration involves the management processes necessary if the new systems are to work at optimum and productive levels. A most common cause for failure in achieving hoped-for productivity gains from automated office equipment is not establishing new management systems that will provide smooth and efficient operations.

A number of critical new management processes must be developed to translate the plan into a successful set of operations. Cost audits and post-installation reviews need to be devised to enable the user to establish and maintain the cost-effective, efficient, service-oriented automated office environment. A permanent staff of service-oriented, technically knowledgeable, bottom-line-oriented personnel must be recruited or developed to manage the new systems.

Step 8. Address key corporate issues. Finally, identify and resolve organizational issues such as end-user

involvement, information policies, security standardization and operational responsibilities to ensure acceptance, and proper coordination and control of office automation strategies and implementation.

Top Management Briefing

In summary, management must be aware that office automation is not simply the acquisition of new and better technology to achieve productivity gains. Equipment alone is not the answer, and management must stop the unplanned proliferation of machines to ensure a cost-justified, totally integrated, strategic approach to the office. A comprehensive program must be devised that will provide such key benefits as:

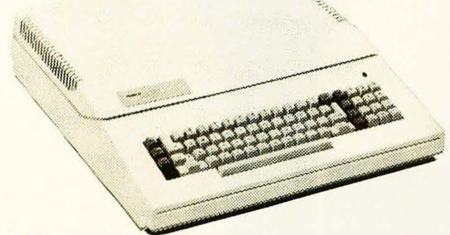
- standardized base line studies to ensure company-wide conformity and a base for future cost-justification
- compatible backbone equipment selection to allow for future systems integration
- bulk discount purchasing where feasible
- education and training programs for clerical, secretarial, and professional staff
- internal expertise in office technology to design and manage systems and benefits

An office automation conversion cannot be successful without senior management guidance and support. While office automation offers an important strategic opportunity for business in the 1980s and promises increases in productivity, as with any new opportunity, only the best will manage to reap those benefits fully. Specific strategies and goals help to maintain viable operations and garner increases in output. The '80s will be the decade when automated tools will be mastered and accepted as commonplace in the office. Yet the process is bound to be a somewhat painful one; mistakes will be costly. Delay may be irresponsible; haste, catastrophic. Management must find an approach to best utilize new technologies to achieve that shimmering goal—increased white-collar productivity and profitability. ■

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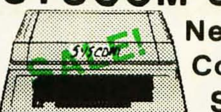
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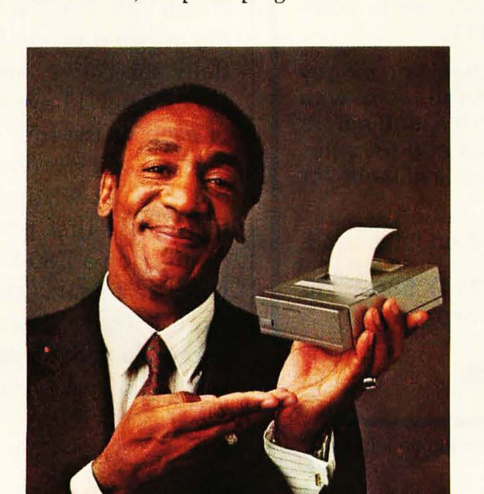
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Preliminary Cautions

A word-processing program is a tool, and, just as you choose a hammer that fits your hand, you should choose a program that fits both the job to be done and your working style. That means you should try out the software before you buy it. Most computer users will certainly want to buy their word-processing software from a retail computer store or dealer, not only to try out the program before buying but to be able to ask questions there after the purchase. The state of the art in user's manuals is still not sufficiently advanced that I can recommend giving a new program to an inexperienced user without a live person somewhere around to give advice and render help.

Four major users of word processors: an author of magazine articles, a marketing manager doing mass mailing, a personal secretary, and a newsletter editor.

As many different word-processing jobs exist as there are things that people want to write. But the capabilities you may need in a system do fall into a few broad categories. For instance, Dr. Larry Press, in a 1980 article in *onComputing* magazine (precursor to *Popular Computing*, see reference 8), outlined four major kinds of word-processing work, typified by four users: an author writing long continuous articles, a marketing manager doing mass mailings of form letters, a secretary typing many short personalized letters, and a newsletter editor concerned about document merging and exact formatting.

There are also a number of ways to test word-processing programs. Some authorities count the number of available features; some weigh the balance of features for different tasks. Some people look for only one or two features that may be vital in certain jobs; others avoid characteristics judged undesirable. No list of features can fully capture the feel of using a program, just as knowing the weight and length of a hammer gives you only a rough idea of what it will feel like to pound a nail with it. My method of evaluating these programs has been partially subjective, and here I should state my prejudices.

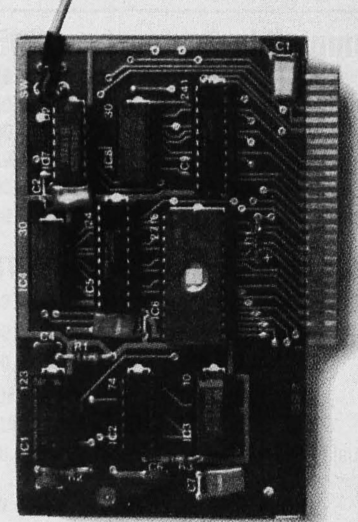
Although I have on occasion done work similar to that of each of the four hypothetical users above, my everyday use of a word-processing program is closest to that of the author: writing, rewriting, and editing lengthy articles. The first program I ever used was Magic Wand running on a Z80-based CP/M-80 system with a Cops-10 video terminal. (Magic Wand, now called Peachtext by its distributor, Peachtree Software, is not reviewed here because a version of it was not available for the IBM Personal Computer when I started this project.) I am a

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At a Glance

Name
Easywriter II

Type
Word-processing program

Manufacturer
Information Unlimited Software Inc.
2401 Marinship Way
Sausalito, CA 94965
(415) 331-6700

Price
$350

Format
Two 5¼-inch floppy disks

Language
C (source code not available)

Computer
IBM Personal Computer

Documentation
User's manual: 92 typeset pages in small loose-leaf binder; function-key sticker

Audience
Beginning users of word processing

moderately fast touch-typist (I usually can type faster than I can think), and I like to place the detached keyboard in my lap.

Simply using Easywriter II, Volkswriter, Wordstar, and The Final Word was the most important test I could put them to, but my conclusions are inevitably *affected* by the factors I've listed above. Your needs and desires will inevitably differ from mine. That's all the more reason to try any program before you buy.

Easywriter II

Only the name is the same here. Easywriter II is a completely different program from the Easywriter sold by IBM. The II suffix is intended to distinguish this Easywriter package, written in the C language for IUS by the Basic Software Group, from the IBM-distributed program (Easywriter 1.0 and Easywriter 1.1), written in FORTH by Cap'n Software. Easywriter II is being sold directly by and through the dealers of Information Unlimited Software Inc., not by IBM.

Information Unlimited Software certainly has learned from IBM how to package Personal Computer software; Easywriter II is sold in a boxed, 9¼- by 8-inch, linen-covered loose-leaf binder that is perfectly coordinated in appearance with IBM's Personal Computer documentation.

IUS was not able to coordinate certain other characteristics of its new program quite as well, at least at first. In

Word Tools for the IBM Personal Computer

Richard S. Shuford
Special Projects Editor



Photo 1: *Four currently available word-processing programs for the IBM Personal Computer (Model 5150): Easywriter II, from Information Unlimited Software; Volkswriter, from Lifetree Software; Wordstar, from Micropro International; and The Final Word, from Mark of the Unicorn. (All photos by Ed Crabtree.)*

The BYTE editorial staff was clustered in the computer lab eagerly watching text scroll up the screen of a video display. The date was August 13, 1981, and we were watching Phil Lemmons' first report on the announcement of the IBM Personal Computer (reference 6) come in through a modem connection.

"Aha," someone said, reading from the screen, "IBM is offering an impressive set of software: Microsoft BASIC, Visicalc, the Peachtree business package, UCSD Pascal, CP/M-86, and . . . Easywriter?" We were sufficiently surprised at the appearance of this program from the realm of Apple computers that we later called Phil to double-check; the Easywriter word-processing program, from Information Unlimited Software, just didn't seem to fit with the other pieces of software in that initial announcement.

Before long, many purchasers of the IBM Personal Computer (PC) were also surprised by Easywriter, and unpleasantly so. The first Easywriter package, Version 1.0, quickly developed a reputation for user-unfriendliness and annoying bugs. Eventually IBM released the improved and more reliable Version 1.1, but the impression had been made and many independent developers of software perceived a ripe opportunity to sell an alternative word-processing program for the IBM PC.

In trying to seize this opportunity, some developers rushed dubious programs to market in the guise of word-processing software. But enough time has now gone by that a state of dynamic equilibrium (although certainly not a state of calm) has settled over the market for IBM PC word-processing programs, and most users will be able to find a program that meets their needs. In this article, I'll tell you about four candidates: Easywriter II, a new and different pro-

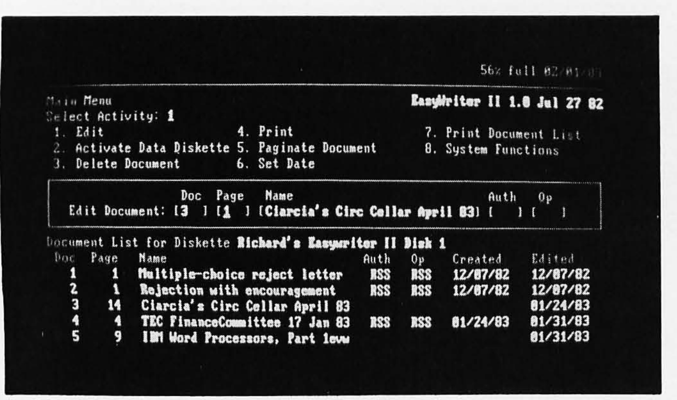


Photo 2: *The first thing Easywriter II does is give you a menu of possible activities. The special file system keeps track of a certain amount of document history, as you can see here from the directory of one disk. Two of the documents were "imported" to the Easywriter II disk environment from a PC-DOS disk; therefore, parts of their histories are missing. The file names appear on the screen in bright-intensity characters, most other things in normal intensity. You call up a document by typing only its number, not its full name. This photo was taken from the screen of an IBM Monochrome Display, as were all other screen shots in this article except photo 13.*

```
CHAR                                                    56% full 02/01/83
Space  1 Line 33 Page  1 Doc  5 IBM Word Processors, Part 1evw        FULL
L  T   1        2        3 C     4        5        6    R  7
     The BYTE editorial staff was clustered in the computer lab
eagerly watching text scroll up the screen of a video display.
The date was August 20, 1981, and we were watching Phil Lemmons'
first report on the announcement of the IBM Personal Computer
(reference L) come in through a modem connection.
     "Aha," someone said, reading from the screen, "IBM is
offering an impressive set of software: Microsoft BASIC,
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impression had been made and many independent developers of
software perceived a ripe opportunity to sell an alternative
word-processing program for the IBM PC.
_    In trying to seize this opportunity, some developers rushed
```

Photo 3: *A typical editing screen display produced by Easywriter II. The top three lines of the screen are used to show a variety of status information and transient messages, including the current text-object mode (CHAR for character), percentage of the document disk used (56 percent), the current date, the cursor position ("Space" means column), the current page number, the name of the document, an indication of space left in the current page, and a tab ruler. All characters have normal video attributes (not especially bright, inverted, blinking, or otherwise).*

the version I tested, the biggest such discontinuity was that Easywriter II did not run under PC-DOS (also known as MS-DOS, the most widely used disk operating system for the IBM Personal Computer). It ran in its own disk environment, storing its files in an incompatible format and requiring that floppy disks be specially formatted for storing documents.

The unique disk environment caused other problems. The Easywriter II software was divided onto two disks: a "system" disk and a "housekeeping" disk. Even such a simple operation as copying document files required an annoying number of manual disk changes, and operation on a single-disk-drive system was impossible. Only single-sided floppy disks were supported, with a capacity of less than 100,000 bytes' worth of documents on one disk (on a double-sided drive, only one side was used). A utility program on the housekeeping disk converted Easywriter II files to PC-DOS format and vice versa, but it could copy correctly only onto single-sided disks; this undocumented fact caused me some frustration. "Importing" a 21,504-byte file to an Easywriter II disk took 2½ minutes.

At least one of the effects of the Easywriter II disk structure was good. The structure allowed long (30-character) document names (like "TEC FinanceCommittee 17 Jan 83") and the keeping of a certain amount of document history: author's and typist's names, size in pages, and dates (but not times) of creation and last modification (see photo 2). Each document on a data disk was assigned a sequence number by the system, so that you did not have to type those long file names; you referred to documents by number.

Easywriter II depends heavily on the use of on-screen menus and function keys.

The verbs in the preceding section are intentionally past tense. According to a telephone conversation I had with a representative of IUS, a new version of Easywriter II should be available by the time you read this. The new version is intended to run under PC-DOS, and most, if not all, of the inconveniences caused by the disk environment should be removed.

I found the editing command structures in Easywriter II to be quite different from those of the other microcomputer word-processing programs I have used. Easywriter II is organized around pages and modes. The computer's video-display screen is used as a window onto one page of the document (see photo 3); normally, you can scroll only up and down on this single page, and you have to issue an explicit command to move to the next page or a previous page, either of which takes about 4 seconds. The most text you can cram into one logical page is about 200 lines, and the computer will remind you of every line entered on a page past line 54 (or a number you set).

The action of any editing and most cursor-movement commands depends upon the current object mode. Seven possible modes each correspond to one defined text object (character, word, sentence, paragraph, line, block, and page). Each command acts upon the object named by the mode currently in effect. To select the object mode, you press one of the 10 assignable-function keys (F1 through F10) on the left side of the keyboard or, in some cases, a function key plus the Shift key. Some of the more dangerous operations (like delete page) require explicit

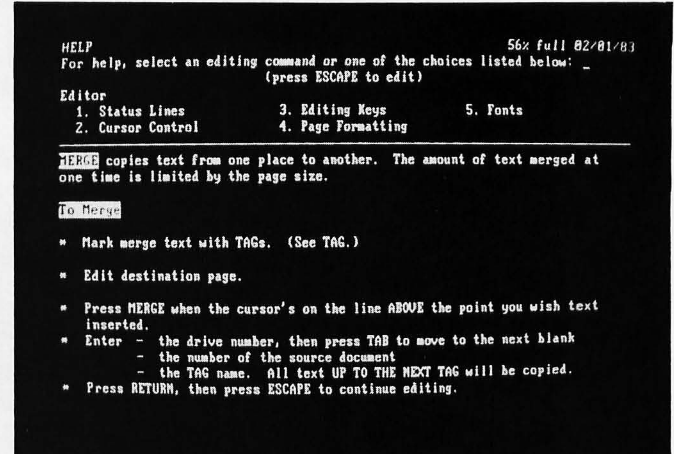


Photo 4: *Easywriter II relies heavily on "help" screens to coach new users on how to use the system, rather than lengthy chapters in the written documentation or online tutorial files. After you hit the F2 function key, you are presented with a menu of possibilities. Shown here is the explanation of the merge function.*

confirmation. The keys of the numeric/cursor-control keypad on the right are also used.

Easywriter II depends quite heavily on use of both on-screen menus and the function keys. The use of menus is common enough, but use of the function keys deserves some attention. The assignable keys F1 through F10 are used both unaugmented and along with the Shift and Alt (alternate) keys. IUS provides a reference sticker as an aid in remembering what the function keys do, and I gather that you are supposed to affix the sticker to the front panel of the IBM PC system unit, between the disk drives and the IBM nameplate. The sticker has one great deficiency: it's too small. The words within the key outlines seem to be in 5-point type and are impossible to read without leaning up close.

The page orientation, the object modes, and the heavy, enforced use of the function keys combined to make me dislike editing with Easywriter II. I don't put much significance on page divisions in the documents I write and edit (this article, for instance), and it's much more convenient to be able to scroll up and down through a large buffer containing the whole document. And with Easywriter II, block-move and block-copy operations cannot occur in block sizes greater than one page.

When editing text, I like to make both large and small changes in the same pass through the text. Easywriter II assumes that you will make changes mostly at the level of one text object at a time. I also found myself forgetting what mode was in effect (even though a status line on the screen indicates this) so that I often changed the wrong text object. Furthermore, I like to leave my fingers in the home position on the keyboard, so that I'll know where they are and only rarely need to look at them to guide my keystrokes. Using Easywriter II, you have to use the function keys a *lot* to change between the modes, and you have to lift your hands out of the home position and look down at them to hit most of the function keys (while

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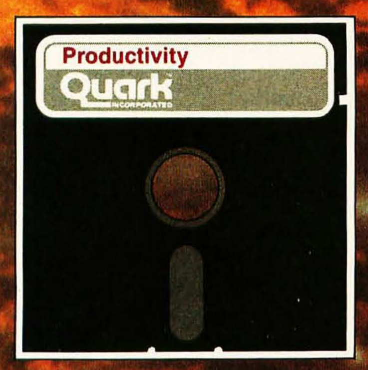
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squinting at the reference sticker). This sort of thing slows me down. You use the keyboard's directional cursor keys, which require you to move from home position, to move the cursor. It's not that I object to function keys in themselves, but there should be a way for expert users to streamline their actions.

My objections don't apply to some users. If you are new to computers (see photo 4), you may appreciate having certain keys dedicated to common functions, and if you are a hunt-and-peck typist you won't care about the home position. And again, if you do only light editing of your text once you have entered it, these problems will be negligible. But once you have learned the system, if you come to use it frequently for editing and revision, you just might get tired of moving your hands back and forth every other keystroke.

You format text for printed output from Easywriter II chiefly by getting it to look on the screen the way you want it on paper. (I'll have more to say about such screen-oriented formatting later on.) A "ruler" line on the screen defines tab settings, margins, and page centering; as many as eight rulers may be used for each document. Decimal-tab settings allow easy alignment of columns of figures, although no column-move facilities are provided. Different headers and footers may be defined for left and right pages, with page numbering placed as desired.

Printing can occur while editing is taking place, including immediate printing of the page just edited. The version of Easywriter II that I tested was unable to drive a serially interfaced Integral Data Systems Prism printer at full speed; IUS is planning to speed up the new version to avoid this problem.

The program I had didn't contain a true global search-and-replace function (the updated version is supposed to have one). An update of the documentation is planned, giving more tutorial examples.

A few other comments are in order: Online help for most functions can be gotten by simply pressing the F2 key. Whenever you wish to take a break from working, you can hit the Escape key, and the page you are working on will automatically be stored on disk against the possibility of some system mishap while you're gone. Sections of one document may be tagged to be merged with another document. No extra backup copies of files

Text continued on page 196

Property	Easywriter II	Volkswriter	Wordstar	The Final Word
Price	$350	$195	$495	$300
Printed documentation	9¼- by 8- by 1¾-inch binder, 92 typeset pages, 5-page index; linen-covered box; function-key sticker	9- by 7- by 1½-inch binder, about 70 typeset pages, 5-page index	12- by 10- by 1¾-inch binder, 230 pages, 5-page index, 14 pages specific to IBM PC; pocket reference card; separate tutorial workbook	12- by 10¾- by 2¾-inch binder, 402 pages, 8-page index; reference card; function-key chart
Minimum practical hardware configuration	64K bytes of RAM, 80-character display, two 5¼-inch floppy-disk drives (reviewed version supports only single-sided drives), and printer	64K bytes of RAM, 80-character display, one 5¼-inch floppy-disk drive, and printer	128K bytes of RAM, 80-character display, two 5¼-inch disk drives (double-sided recommended), and printer	128K bytes of RAM, 80-character display, two 5¼-inch double-sided floppy-disk drives, and printer
Maximum number of characters directly manipulable	window sees only one page at a time; number of pages in file varies with disk size	with 128K bytes, 58,570 characters; with 64K bytes, 15,370 characters	varies according to disk size	varies according to disk size and user-set size of swap file
Editing universe	window into one page of file	window into buffer in RAM	window into buffer automatically paged to and from disk	window into buffer automatically paged to and from disk; supports two windows and multiple buffers
Command structure	mode-oriented; uses menus and special- and assignable-function keys plus Alt and Shift keys	uses special- and assignable-function keys plus Alt key	control keystrokes organized by two-level menus, limited function-key support	control keystrokes organized by three-level menus, user-definable function-key support; mode-oriented
Tutorial course for beginners?	first chapter in user's manual	files for online tutorial provided on disk	separate stand-up beginner's workbook (introductory textbooks available from independent sources)	nine chapters of user's manual, some chapters also provided on disk for online practice
Online help during editing?	separate screen displays explaining function keys and editing procedures, placed on screen after user types F2	brief descriptions of function keys placed on screen after user types F1	command menus appearing at top of screen after user types proper control character (menus may be suppressed by expert users)	command menus at top of screen appearing after user types Control-X, also brief messages on command sequences and keystroke functions

Table 1: *Comparative properties of four word-processing programs for the IBM Personal Computer.*

Table 1 continued on page 190

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$449 PL/1-80

BT-80 ... $179
MAC ... $85
RMAC ... $179
Sid ... $65

$90 Z-Sid

DeSpool ... $49
CB-80 ... $459
Link-80 ... $90
FOX & GELLER
Quickscreen ... $135
Quickcode ... $265

$65 DUtil

MICRO-AP
S-Basic ... $269
Selector IV ... $295
Selector V ... $495
MICRO DATA BASE SYSTEMS
HDBS ... $269
MDBS ... $1099
DRS or QRS or RTL ... $319
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$289 WordStar
$199 Mail Merge

WordStar/Mailmerge ... $399
WS/MM/SpellStar ... $549
Customization Notes ... $44

$199 SpellStar

DataStar ... $249
InfoStar ... $349
ReportStar ... $254
Wordmaster ... $119
Supersort I ... $199
Calc Star ... $129
MICROSOFT

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$349 Fortran-80
$549 Cobol-80

M-Sort ... $175

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dBASE II ... Call 4??
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SpellGuard ... $199
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Spell Binder ... $349
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The Word ... $65

$145 The Word Plus

Palantier-1 (WP) ... $385
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Ascom ... $149
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$89 Move-it

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Target PlannerCalc ... $79
Target Financial Modeling ... $299
Target Task ... $299
Tiny "C" ... $89
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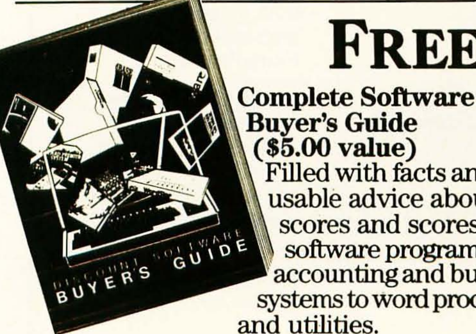
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BM 583



Property	Easywriter II	Volkswriter	Wordstar	The Final Word
Longest line length that can be set	255 characters (horizontal scrolling possible)	80 characters	240 characters (horizontal scrolling possible)	65,535 characters (no horizontal scrolling; line is wrapped back onto screen for display only)
On-screen status information shown during text entry and editing	text-object mode in use; percentage of document disk used; current date; cursor position (column, line, page); document name; margins; tab stops; page center; right-hand word-wrap zone; other transient messages	disk drive being used for file accesses (logged drive); cursor line and column; percentage of buffer unused; cursor is enlarged during insert mode; additional transient messages	active file name; current page; cursor line and column; insert mode on or off; line spacing; margins and tab stops; page breaks; various line-ending codes; optional command menus; other transient messages	version of The Final Word in use; text insert/alignment mode; current buffer name; file name associated with current buffer; percentage of buffer contents behind cursor; "*" if buffer has been modified; "+" if new deletions will be appended to old; "H" if new text will be highlighted; current "verb" (actually adverb); transient messages
Screen location of status information	three lines at top, normal character attributes	bottom line, inverse video	top two lines (if menu suppressed) of rightmost column; menus occupy several lines at top of screen, in both normal and bright intensities	next-to-bottom line, inverse video; transient messages appear on bottom line; menus on several lines at top of screen
Use of IBM PC function keys	extensive, mandatory; uses Alt and Shift keys with assignable keys; function-key sticker provided	extensive, mandatory; Alt key doubles functions; on-screen key menu	optional; curious choice of key assignments	optional; uses Alt, Shift, and Control keys with assignable keys; key chart provided; assignments may be changed by user
Action of Del key	deletes current text object	deletes character to the right of cursor	deletes character to the left of cursor	deletes character at cursor
Action of back-arrow key	nondestructive backspace	destructive backspace (replaces character with a space)	nondestructive backspace	delete character backwards
Decimal tab stops?	yes	no	yes	no
Column-move capability?	no	no	yes	no
Possible insertion of nonprinting ASCII control characters?	no	yes	no	yes
Formatting scheme	on-screen	on-screen; some printing parameters stored in disk files	on-screen	both on-screen and embedded-command formatting possible
Transition time from edit mode to printing start (includes answering queries as fast as reasonably possible)	reviewed version: 25 seconds for 28,469-character (or 9-page) file	128K-version: 16 seconds for 28,469-character file printed directly out of buffer; 64K-version: 48 seconds for same file, includes saving to disk	60 seconds for 28,469-character document, includes saving to disk	for 28,167-character document, without embedded-character formatting: 1 minute, 35 seconds; for same document with formatting: 4 minutes
Print while editing?	not reliably	no	yes	yes
Obtain file directory without leaving program?	document files only	yes	yes	yes
Can user change default parameters?	some (with menu-driven utility program)	those in format (.FMT) files	only printer-support parameters	most print and edit defaults (with menu-driven utility program)

Table 1 continued on page 192

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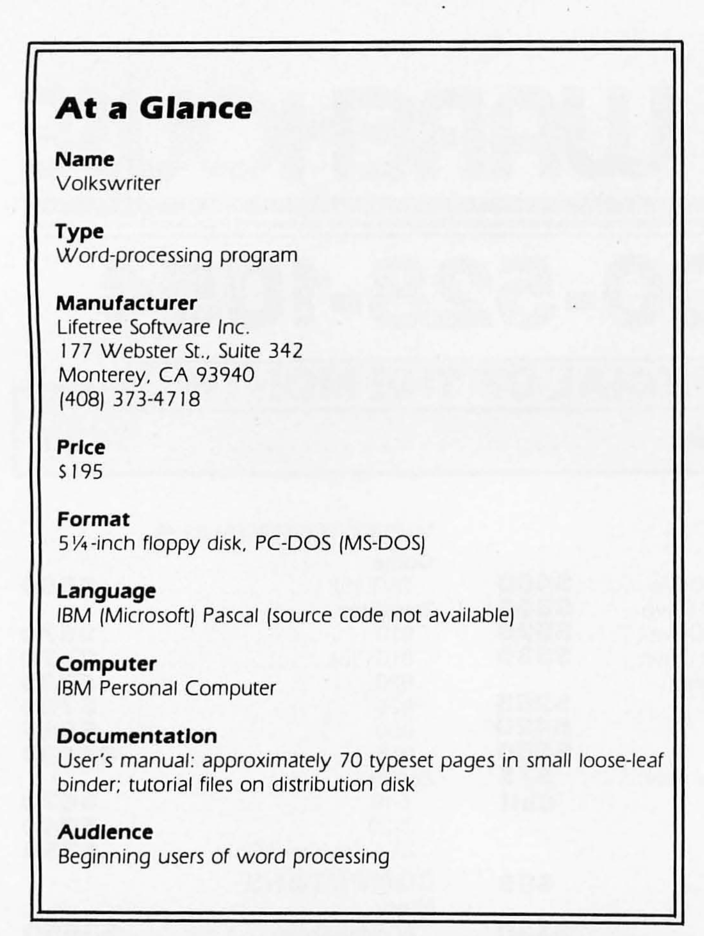
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Property	Easywriter II	Volkswriter	Wordstar	The Final Word
Document assembly during editing	includes "tagged" sections of other document files	can include entire files	can include entire files; marked blocks of files may be written to disk	marked blocks of text may be transferred between two buffers
Document assembly during printing	no documented method	can embed entire files in output	needs optional Mailmerge program at extra cost	can embed entire files in output
Accept operator input for immediate inclusion in printed output?	no	no	needs Mailmerge	yes
Automatic formatting capabilities (other than defaults)	multiple-line headers and footers, alternating left and right	page formatting through .FMT files	single-line headers and footers	extensive and complex capabilities through embedded commands
Default text-justification style	flush-left (ragged-right margin)	flush-left (ragged-right margin)	fully justified	fully justified (as distributed; user can change)
Can documents be printed without being saved to disk?	yes	yes	no	no
Difficulty of changing from single spacing to double spacing	difficult	easy	difficult	easy, requires use of formatter
Can text be searched for printing attributes?	no	yes	no	yes
Printers supported (not all printers can output all text attributes)	IBM Parallel Printer; Epson MX-80; Diablo 1610*; Diablo 1650 (with sheet-feed); Diablo 630*; NEC 5510*; and C. Itoh Parallel* (others, without full capability **requires adjustment of numeric parameters from chart*	IBM Parallel Printer; Epson MX-80 (with and without Graftrax); Smith-Corona TP-1; Brother HR-1; Comrex CR-1; NEC 8023-A; and NEC 3550 (other printers, without full capability)	IBM Parallel Printer; Epson MX-80; Diablo 1610/1620; Diablo 1640/1650; Diablo 630; NEC 5510/5520; NEC 3550†; Qume Sprint 5; and C. Itoh Starwriter (others, without full capability) *†partial support*	IBM Parallel Printer; Epson MX-80 with Graftrax; C. Itoh 8510; Leading Edge Prowriter; Diablo 1610/1620; Diablo 1640/1650/630; NEC 8023A; NEC 3550; NEC 5510/5520; Qume Sprint 9/35; IDS 440/460; IDS Prism; Centronics 737/739; and Radio Shack Daisywheel II (others, with varying capability)
Special features of disk-file format	nonstandard file format in tested version; file-conversion utility produced normal PC-DOS files; new version to use PC-DOS files	"¶" character (ASCII decimal 20) at hard returns, "§" character (ASCII decimal 21) at page ends; otherwise normal PC-DOS files	high bits of character bytes set at ends of words and at soft returns; soft (ghost) hyphens and other special attributes use nonprinting ASCII values	normal PC-DOS files; high bits of character bytes set only in highlighted text
Checking of spelling integrated into program?	no	no	yes (with optional program Spellstar at extra cost)	no

Table 1 continued on page 194

Property	Easywriter II	Volkswriter	Wordstar	The Final Word
Most annoying characteristics	multiplicity of text-object modes; (in version tested) incompatible disk format, single-sided-disk use even on double-sided drives, necessity to change disks for routine functions; lack of ability to search text for printing attributes	block operations by groups of lines only; 80-character maximum line length; (to expert users) required use of function keys	unchangeable default conditions; tedious method of printing same text in two different formats; lack of planning in adaptation to IBM PC hardware; lack of ability to search for printing attributes	enslavement to forward and reverse modes for most editing operations; lack of single-line screen scrolling; inadequate differentiation in documentation between certain similar features; requirement of two return characters between paragraphs; inflexible tab-setting
Most pleasing characteristics	long, descriptive document names (30 characters in length); use of ordinary "cut-and-paste" terminology; accuracy in the reproduction of IBM's documentation binder	quickness of screen scrolling; simplicity of design; storage of canned formats; ability to insert almost any ASCII character into text	efficient grouping of control characters for cursor movement and other often-used operations; variable amounts of user prompting through repressible menus	extreme flexibility; protection against interruptions and system crashes; ability to view and edit two documents at once in two visible text windows; provision of Control-T command to correct two-character transposition typos
Miscellaneous comments	Special telephone-help service may be purchased for $70 per year. Second serial port cannot be used for printer.	You purchase a version tailored to run on a 64K-byte system; when you send in the registration card, you are sent the 128K version. Owners of version 1.1 may receive an upgrade to 1.2 for $20.	Wordstar has provision for helping hyphenate words during reforming of paragraphs. Text is displayed on screen in bright attribute, menus in normal attribute.	TFWINM (see text); does not use "meta" characters for commands. Uses Recover program to maintain swap file. Printer paper may be offset to save forms. Screen-highlighted text shows up in blue on a color monitor.



At a Glance

Name
Volkswriter

Type
Word-processing program

Manufacturer
Lifetree Software Inc.
177 Webster St., Suite 342
Monterey, CA 93940
(408) 373-4718

Price
$195

Format
5¼-inch floppy disk, PC-DOS (MS-DOS)

Language
IBM (Microsoft) Pascal (source code not available)

Computer
IBM Personal Computer

Documentation
User's manual: approximately 70 typeset pages in small loose-leaf binder; tutorial files on distribution disk

Audience
Beginning users of word processing

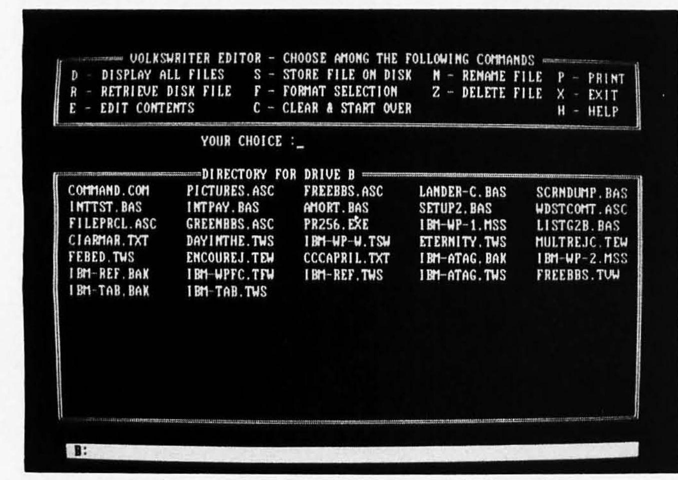


Photo 5: *Volkswriter consistently places the list of major menu choices at the top of the screen, with subsidiary information arranged underneath as required. Shown here is the main menu, which appears on the screen after a brief graphical diversion.*

Text continued from page 186

are made unless you give explicit commands to cause it. No automatic-hyphenation functions are provided. A crude kind of "undo" command can, under most conditions, cancel changes to a page made since it was called up. Some other specific features are delineated in the comparison in table 1 (see pages 186–194).

Volkswriter

Volkswriter, or VW as its devotees call it, was one of the first alternatives to the original Easywriter. VW runs under PC-DOS and is one of the few word-processing programs for the IBM PC that can be run (although not at top performance) on a fairly small hardware configuration, i.e., 64K bytes of user memory and one 5¼-inch floppy-disk drive. Lifetree Software provides two different sets of program files (see photo 5) for registered users of VW: one set, to be used in systems with 64K bytes, contains separate programs (linked in execution by batch files) for Volkswriter's editing and printing functions; the other set, to be used with 128K bytes or more, combines the two programs into one.

In keeping with its modest hardware demands, Volkswriter is moderately priced. With a suggested list price of $195, VW is the least expensive of the four tools considered in this article. The program is simple in design, and I found it quite straightforward to use for modest writing projects. It's a no-frills piece of software: it has just enough features to get most jobs done.

Lifetree Software doesn't come as close as Information Unlimited Software in imitating IBM's user's manuals, but some thought was given to the matter, because the loose-leaf binder and box are roughly the same size as IBM's, although covered with slick paper instead of linen.

To initiate first-time users to the concepts of word processing and its peculiarities, VW depends less on the user's manual than on a series of interactive lessons. You take the lessons by editing a set of files that comes on the Volkswriter distribution disk. I found the lessons to be well done except for a couple of problems, such as a search-and-replace lesson that became unintentionally modified by being searched and replaced. (These glitches can be considered minor if a knowledgeable user can be consulted by the person taking the lesson.)

In contrast to Easywriter II's page orientation, Volkswriter treats the display screen like a window onto a large, continuous buffer, or storage area, containing the entire text you are editing. Both the buffer and the Volkswriter program itself must fit simultaneously in user memory, so that the amount of text you can work on in a 64K-byte system is limited to around 15,000 characters. But this limitation makes possible great speed in moving the window around in the buffer. You never have to wait for the word-processing program to read more text from a floppy disk; it's always immediately accessible. In a 128K-byte system, you can work on a buffer size of as many as 60,000 characters. The status line at the bottom of the screen tells you what percentage of the buffer is available for entering text, although for some reason it starts out at 93 percent empty instead of 100 percent.

Like Easywriter II, Volkswriter uses the 10 assignable-function keys heavily to invoke various commands; the Alt key is used to double the commands available with the assignable-function keys. Also as in Easywriter II, you must use these keys; there is no alternative for the expert user. The keys of the numeric/cursor-control keypad on the right side of the keyboard are used also as they are marked. My feelings about having to use the assignable-function keys in Easywriter also apply to VW, but I

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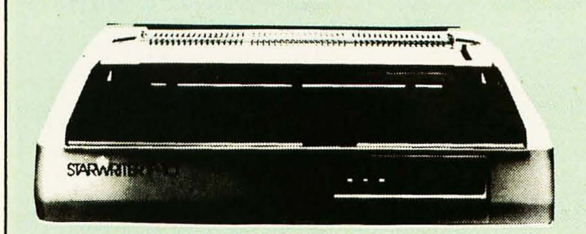


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- Centronics parallel or RS-232C interfacing (specify)

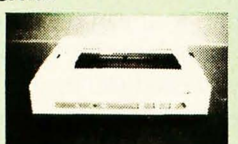
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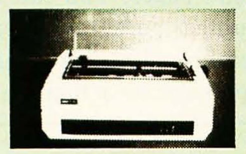
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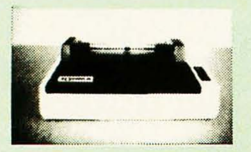
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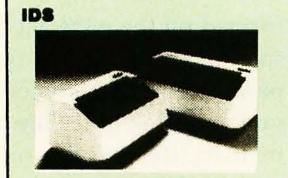
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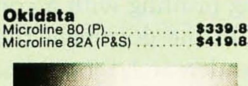
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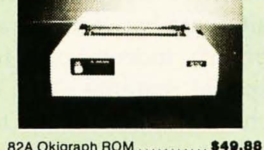
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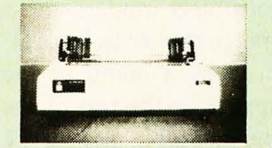




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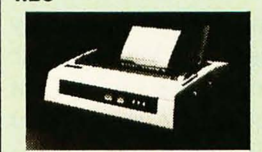
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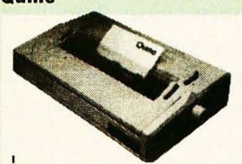
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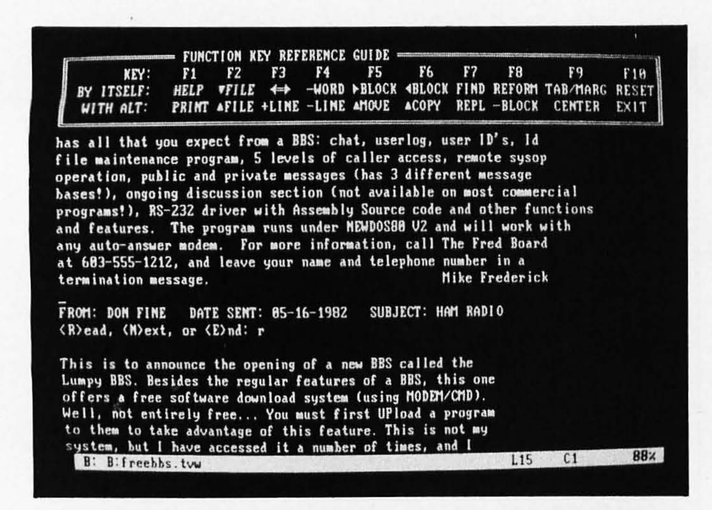


Photo 6: *Typical screen display in Volkwriter's edit mode. By hitting the F1 key, you cause the reference guide to the assignable-function keys to appear at the top of the screen. This is the only online help available, however. The bottom line of the screen shows status information in inverse video.*

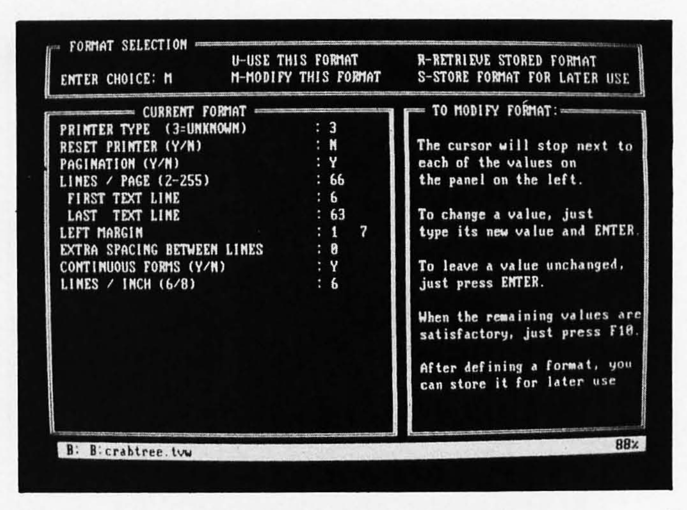


Photo 7: *Parameters of Volkswriter's printing format are stored in disk files given file name extensions of ".FMT". You can change the parameters using a simple, menu-driven procedure, illustrated here.*

didn't find editing with VW as objectionable as Easywriter II, perhaps because the effects of VW's commands are not modified by a lot of object modes.

Lifetree does not give you a reference sticker to look at, but by pressing the F1 key, you cause a menu of the assigned command functions to appear at the top of the display screen (see photo 6). (Incidentally, use of F1 makes more sense than Easywriter II's use of F2.) The legends are somewhat cryptic to the new user, but once you have become familiar with Volkswriter the display makes sense. Also, the F10 key is used as a kind of panic button; you can press it to halt an operation you did not intend. The system is kind to inexperienced users in that it asks you to confirm your intentions when you give it a command that could wipe out a large part of the text.

The printed output that Volkswriter produces is formed on the page according to parameters specified by special format files (given ".FMT" extensions). The parameters vary somewhat depending on what printer you are using, but they can include the character pitch to be used, the margins on the page, line spacing, justification, and starting page number. You can set up separate format files (see photo 7), automatically invoked, for each type of document that you produce, or you can use the default format. You can even change the formats during printing with a command embedded in the text.

In the document file, you can embed any number of header and footer lines, with justification specified to alternate between left and right pages. You can set temporary indentations for quoted paragraphs or other special material. You can embed almost any arbitrary character code in the text, perhaps to activate a special

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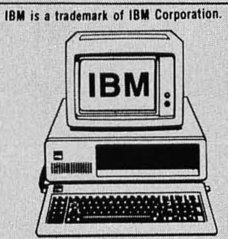
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128K RAM Card w/Parity	$ 525	$380
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Quadboard, 128K, expandable to 256K, 4 function board	$ 775	$565
Quadboard, 192K, expandable to 256K, 4 function board	$ 895	$635
* Quadboard, 256K, four function board	$ 995	$670
Quad 512+, 64K plus serial port	$ 475	$325
Quad 512+, 256K plus serial port	$ 895	$595
Quad 512+, 512K plus serial port	$1295	$895
Microfazer, w/Copy, Par/Par, 8K, #MP8	$ 159	$119
Microfazer, w/Copy, Par/Par, 64K, #MP64	$ 299	$235
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Microfazer, Snap-on, 64K, Par/Par, Epson, #ME64, w/PSI	$ 299	$235
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ANADEX, DP8000 Dot Matrix, 120cps, Serial & Cent. Para. I/F	$ 995	$495
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Comriter Tractor Feed for CR-1	$ 118	$ 99
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8" CP/M-80

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MICROCRAFT, Legal Billing & Time Keeping — Verdict	$ 750	$395
Prof. Billing & Time Keeping — Billkeeper	$ 750	$395
MICROPRO, WordStar® plus free WordStar Training Manual	$ 495	$249
MailMerge™	$ 250	$159
SpellStar™	$ 250	Call
3 Pak, Word & Mail & Spell, 3 above	$ 845	Call
InfoStar NEW!	$ 495	$335
ReportStar NEW!	$ 350	$235
MICROSOFT Multiplan	$ 275	$199
Fortran 80	$ 500	$325
BASIC Compiler	$ 395	$295
COBOL-80	$ 750	$545
BASIC-80	$ 350	$275
muLis/muStar-80	$ 200	$145
M-Sort-80	$ 195	$145
Edit-80	$ 120	$ 80
Macro-80	$ 200	$145
PEACHTREE, Magic Wand	$ 500	$195
Series 4 GL, AR, AP or Inventory, each	$ 600	$395
Series 8 GL, AR, AP, Inv or Pay each	$ 750	$495
Series 9 Peach Text	$ 500	$330
Series 9 Spelling Proofreader	$ 300	$195
Series 9 Calc. Mail List or Telecomm., each	$ 375	$245

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NEC, 12" Green, Model JB1201M	$ 249	$159
12" Color, Composite, Model JC1212M	$ 450	$349
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SANYO, 9" Green, Model DM5109	$ 200	$139
12" Green, Model DM8112CX	$ 260	$199
13" Color, Composite, Model DM6013	$ 470	$349
ZENITH, 12" Green, Model ZVM121	$ 150	$ 99
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12" Amber, #300A	$ 210	$159
13" Color I, Composite	$ 449	$359
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13" Color III, RGB, Commercial, (Ap II, III)	$ 569	$469
DVM, Color II or III to Apple II Interface	$ 199	$175

Note: Color II and III come with cable for IBM-PC.

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HAYES, Micromodem II (for the Apple II)	$ 379	$275
Apple Terminal Program for Micromodem II	$ 99	$ 69
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Micro Telegram for Apple II	$ 250	$125
SSM, Transcend 1 for Apple II Data Comm.	$ 89	$ 69
NOVATION, Applecat II Modem	$ 389	$269
212 Apple Cat	$ 725	$599
HAYES, Stock Chronograph (RS 232)	$ 249	$189
Stock Smartmodem (RS-232)	$ 289	$225
Smartmodem 1200 (RS-232)	$ 699	$535
Micromodem 100 (S-100 bus)	$ 399	$275
SIGNALMAN, Modem MKI (RS-232)	$ 99	$ 79
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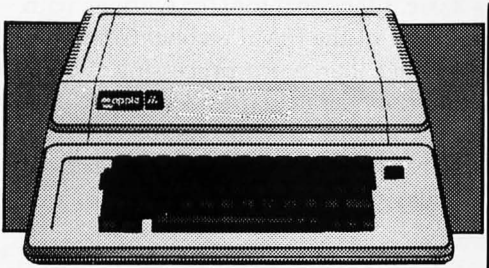
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	Controller Card	$ 89	$ 75
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	Super-5, Controller Card.	$ 89	$ 69
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for Apple II

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★ **ALS**, ADDRam	16K	$ 99	$ 69
★ **Microsoft**, RAMCard	16K	$ 100	$ 79
★ **Saturn Systems**, RAM Card	32K	$ 249	$169
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RAM Card	128K	$ 599	$459
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CCS, Serial Interface 7710A	$ 150	$129
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MBP 16K Para (Epson)	$ 159	$129
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Microbuffer II 32K, (specify)	$ 299	$229
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4Mhz	$ 295	$ 235
6 Mhz	$ 375	$275
RH Electronics, Super Fan II	$ 75	$ 59
SSM, A10 II, Serial/Para Interface	$ 225	$169
TG Products, Game Paddles (II+)	$ 40	$ 29
Joystick (II+)	$ 60	$ 45
Select-A-Port (II+)	$ 60	$ 45
Trak Ball (II+)	$ 65	$ 44
WICO, Trackball (Ap II/II+)	$ 80	$ 55

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Artsci, MagicWindow II NEW!	$ 150	$ 99
Ashton-Tate, dBase II (CP/M) with User's Guide by Software Banc	$ 730	$439
Continental, GL, AR, AP or PR ea	$ 250	$169
1st Class Mail	$ 75	$ 49
Home Accountant	$ 75	$ 49
Hayden, Pie Writer (Specify brd.)	$ 170	$ 99
★ **High Tech.**, Job Cost Control	$ 750	$350
Info Master	$ 189	$119
Howard Soft,		
Real Estate Analyzer II	$ 195	$129
Tax Preparer	$ 225	$149
Info. Unlim., Easywriter (PRO)	$ 175	$119
LJK, Letter Perfect w/Mail Merge	$ 150	$ 99
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Professional Billkeeper	$ 750	$395
Verdict, (Legal Billing)	$ 750	$395
★ **Micro Lab**, Tax Manager	$ 180	$119
Micro Pro, (all CP/M)		
InfoStar	$ 495	$329
Report Star	$ 350	$229
WordStar® + Training Manual	$ 495	$199
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Muse, Super Text 40/80	$ 175	$129
Super Text 40/56/70 New!	$ 125	$ 95
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The Dictionary New!	$ 100	$ 69
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Some Common Basic Programs 75 Business, Statistics and Math programs for the Apple II	$ 100	$ 49
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Series 40 Inv. or Pay., ea	$ 400	$275
Series 9 Text & Spell & Mail, all 3	$ 595	$395

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Perfect, Perfect Writer	$ 495	$239
Perfect Speller	$ 295	$139
Perfect Filer	$ 595	$289
Quality, GBS w/3 gen. (a DBMS)	$ 650	$475
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★ **Silcon Valley**, Word Handler	$ 250	$119
Sof./Sys., Executive Secretary	$ 250	$169
Executive Speller	$ 75	$ 55
Software Dimensions/System Plus.		
Acctg. Plus, General Ledger	$ 425	$295
Acctg. Plus, GL, AP and A/R	$ 995	$595
Acctg. Plus, above + Inventory	$1395	$775
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PFS: Report	$ 125	$ 85
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STC, The Creator NEW!	$ 200	$139
Stoneware, DB Master	$ 229	$155
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At a Glance

Name
Wordstar

Type
Word-processing program

Manufacturer
Micropro International Corporation
33 San Pablo Ave.
San Rafael, CA 94903
(415) 499-1200

Price
$495

Format
5¼-inch floppy disk, PC-DOS (MS-DOS)

Language
Translation from 8080 machine language to 8086/8088 machine language (listing provided of some sections that may be customized by the user)

Computer
IBM Personal Computer (as reviewed)

Documentation
Tutorial workbook Wordstar Training Guide; 230-page user's manual in large loose-leaf binder, printed with letter-quality computer printer

Audience
Users of word-processing software who require advanced features

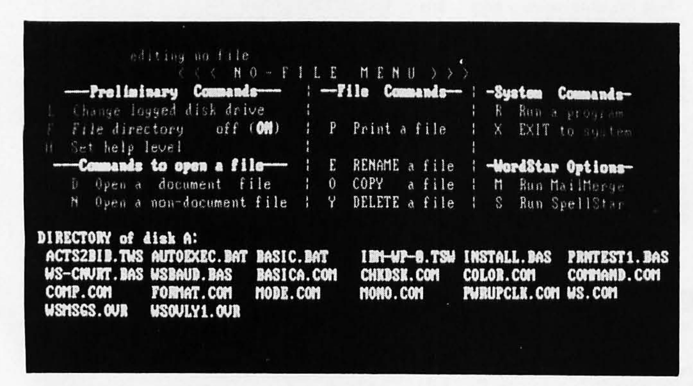


Photo 8: *If no file name is specified in the command line when Wordstar is started, the program places this "no-file" menu on the screen. Menu options are selected when you type a single character. In this mode, you can perform various utility operations and even run a system utility program like CHKDSK (to find out how much room is left on a disk) without exiting Wordstar. The optional Mailmerge and Spellstar programs cost extra.*

function supported by your printer or to use one of the IBM PC's special display characters. Or you can generate certain printing attributes (such as boldface, underlined, or accented characters) by brute force, by explicitly causing two or more lines of text to be printed on top of each other.

Volkswriter has been around long enough to have already undergone some changes from its original design. One change applauded by many users has been the discontinuation of the copy protection of the VW distribution disks; other changes are not as obvious: reassignment of the F3 key, inclusion of conditional page breaks, provision for sub- and superscripting, and support for more printers. One change that has not been made is to provide for placement of block markers to allow block-move operations on pieces of text other than mere groups of lines (such as a sentence partly on one line and partly on another).

Volkswriter is a basic, functional tool for working with words. If your major use of the IBM Personal Computer is for some purpose other than word processing, Volkswriter would be a good, moderately priced software purchase to extend the capabilities of your system.

But if your needs are like mine, you'll want to explore more versatile (and, alas, more expensive) word-processing programs like . . .

Wordstar

This product of Micropro International Corporation is without doubt the best-known and probably the most widely used personal computer word-processing program. Wordstar was developed for use on 8080A- or Z80-based CP/M-80 systems and was first sold in June 1979. It has become a point of reference for word-processing capabilities; whenever a new word-processing program comes on the market, people ask, "How does it compare to Wordstar?"

Wordstar really is a very versatile tool, well suited for many types of document composition and editing, but it is not flawless, and the $495 list price may seem high to many potential buyers. Dr. Larry Press reviewed it in *onComputing*, along with three other programs (see reference 8). He rated it best of the four in certain kinds of work.

The version of Wordstar that I tested was 3.2, which seems to be a translation to the 8086/8088 processor and PC-DOS from the CP/M-80 version. The programmers at Micropro who adapted Wordstar to the IBM PC evidently did a lackluster job. The documentation supplied, contained in a large loose-leaf binder, was that written for the CP/M-80 product, plus a 14-page addendum on features unique to the IBM PC program that contained some confusing typographical misinterpretations. The Wordstar package also contains a self-standing tutorial workbook.

One of Wordstar's hallmark characteristics is its multiple-menu-oriented command structure. When you begin execution of the program, a "no-file" menu appears on the display screen (see photo 8). You select one of the activities listed among the menu items by typing a *single* alphabetic character. Included in the menu choices are running the optional, extra-cost Spellstar spelling-check program and the Mailmerge form-letter program. If you type a "D" from this menu, you will be asked for a document file name; after you respond, Wordstar will load the file into its working text buffer and go into edit mode (see photos 9 and 10 on page 204).

Full Use of the Epson MX-80 Under Wordstar

Neil G. Wallace
11306 Concho Lane
Houston, TX 77072

You can't take advantage of many of the printing capabilities of the Epson MX-80 (or the similar MX-100) printer when you use Wordstar, as distributed by Micropro International for the IBM Personal Computer, unless you change the user-addressable printer-driver routine. This can be done easily using the PC-DOS DEBUG utility program.

Following the procedure given here, you can upgrade Version 3.2 of Wordstar so it can use more of the capabilities built into the Epson MX-80 equipped with Graftrax-Plus. These modifications will enable printing of double-width, italic, and compressed characters, along with super- and subscripts.

Here's how to do it, as derived from information in Appendix C of the Wordstar reference manual and Appendix B of the Epson user's manual:

1. *Copy the Wordstar file WS.COM onto a disk that you can use for experimentation (in case something goes wrong). Also copy the PC-DOS file DEBUG.COM onto the disk. Don't make these changes to your master copy of Wordstar.*
2. *Put the experimental disk into disk drive A of your IBM Personal Computer.*
3. *From the PC-DOS command prompt A>, enter the command:*
   DEBUG WS.COM
   This begins the process of modifying the program.
4. *Type the characters*
   E 0784
   and press the Enter (Return) key. The computer's display should now show
   -E 0784
   04B5:0784 00
   Now type in a "1" and press Enter. The screen will show
   -E 0784
   04B5:0784 00.1
   Enter "Q" and start over if the screen shows something different.
5. *Now type*
   E 0785
   (and Enter). After the "00." in the computer's response, type "8E" and press Enter. The screen will look like this:
   -E 0785
   04B5:0785 00.8E
6. *Now type*
   E 0789
   After the computer prints the "00." type "1". The display will show
   -E 0789
   04B5:0789 00.1
7. *And finish this stage by entering*
   E 078A
   After the "00.", put "94". The display will show
   -E 078A
   04B5:078A 00.94

You have just given Wordstar the ability to tell your MX-80 to print double-width characters. After these instructions have been put into Wordstar, you can use the embedded command ^PW (Control-P, W) to start double-width output and ^PE to turn it off. (Double width will also be turned off automatically at the end of the line.)

But you've just started. The remainder of the changes to Wordstar are done in much the same way. Perform the following summarized steps:

```
E0793
04B5:0793 00.2
E0794                  turn on italics
04B5:0794 00.1B        with ^PY
E0795
04B5:0795 00.34

E0798
04B5:0798 00.2
E0799                  turn off italics
04B5:0799 00.1B        with ^PY
E079A
04B5:079A 00.35

E076B
04B5:076B 00.1         turn on
E076C                  compressed mode
04B5:076C 00.8F        with ^PA

E0770
04B5:0770 00.1         turn off
E0771                  compressed mode
04B5:0771 00.92        with ^PN

E0775
04B5:0775 00.3
E0776                  Turn
04B5:0776 00.9B        superscripts
E0777                  on with ^PT
04B5:0777 00.53
E0778
04B5:0778 00.0

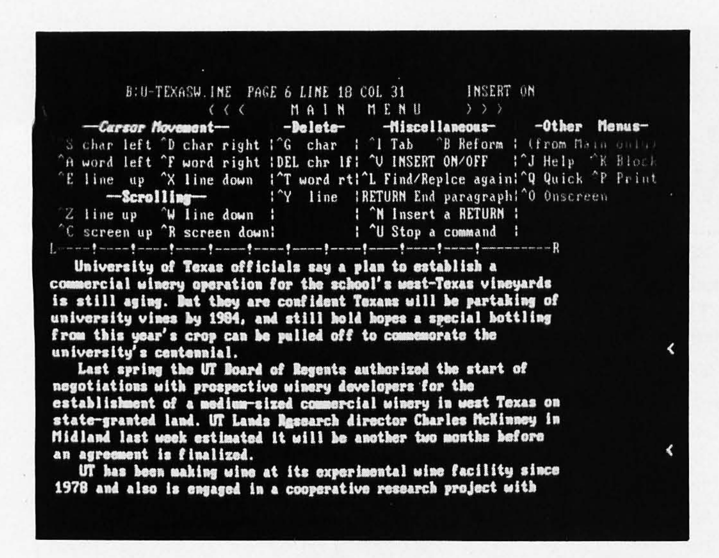
E077A
04B5:077A 00.3
E077B                  Turn subscripts
04B5:077B 00.9B        on with ^PV
E077C
04B5:077C 00.53
E077D
04B5:077D 00.1

E077F
04B5:077F 00.2
E0780                  turns off super-
04B5:0780 00.9B        and subscripts
E0781                  with ^PQ
04B5:0781 00.48
```

Now this is important: you must, after entering all the preceding commands in DEBUG, do one more thing. Enter the following:
W04B5:0100
Your computer will come back with
Writing 5000 Bytes
as it makes your changes to your experimental copy of Wordstar. Then exit DEBUG by typing "Q" and pressing Enter.

You're now through and can try out Wordstar's new capabilities. Use superscript commands in text in the following way: "5^T2^T^Q" will print "5^2". Use subscripts this way: E^V3–x^V^Q will print "E_{3-x}".

Have fun.



```
          B:U-TEXASW.INE  PAGE 6 LINE 18 COL 31        INSERT ON
                    < < <     M A I N   M E N U     > > >
    —Cursor Movement—        -Delete-      -Miscellaneous-     -Other Menus-
 ^S char left ^D char right |^G  char   | ^I Tab   ^B Reform | (from Main only)
 ^A word left ^F word right |DEL chr lf| ^V INSERT ON/OFF   |^J Help  ^K Block
 ^E line  up  ^X line down  |^T word rt|^L Find/Replce again|^Q Quick ^P Print
        —Scrolling—         |^Y  line   |RETURN End paragraph|^O Onscreen
 ^Z line up   ^W line down  |           | ^N Insert a RETURN |
 ^C screen up ^R screen down|           | ^U Stop a command  |
L----!----!----!----!----!----!----!----!----!----!----!---------R
   University of Texas officials say a plan to establish a
commercial winery operation for the school's west-Texas vineyards
is still aging. But they are confident Texans will be partaking of
university vines by 1984, and still hold hopes a special bottling
from this year's crop can be pulled off to commemorate the
university's centennial.                                              <
   Last spring the UT Board of Regents authorized the start of
negotiations with prospective winery developers for the
establishment of a medium-sized commercial winery in west Texas on
state-granted land. UT Lands Research director Charles McKinney in
Midland last week estimated it will be another two months before
an agreement is finalized.                                            <
   UT has been making wine at its experimental wine facility since
1978 and also is engaged in a cooperative research project with
```

Photo 9: *A typical editing screen display produced by Wordstar. Status information is displayed on the top line of the screen; the menu occupies the next several lines. Below the menu is the tab and margin ruler.*

The text being edited and the category headings in the menus appear on the screen in bright intensity, while menu items and status information appear in normal intensity. Because this practice differs from most IBM PC programs, you may need to readjust the contrast and brightness of your video monitor to find a comfortable brightness level. At the right side of the screen, line-ending markers ("<") show that two of the lines (at the ends of paragraphs) end with "hard" return characters; the other lines end with "soft" returns, which can be removed when paragraphs are reformed (realigned).

```
          B:U-TEXASW.INE  PAGE 6 LINE 23 COL 24        INSERT ON
L----!----!----!----!----!----!----!----!----!----!----!---------R
state-granted land.  UT Lands Rsesearch director Charles  McKinney
in  Midland  last  week estimated it will be  another  two  months
before an agreement is finalized.                                     <
   UT has been making wine at its experimental wine facility since
1978  and  also is engaged in a cooperative research project  with
Texas Tech in Lubbock. _A 1981 French Colombard,  produced through
the  UT/Texas-Tech research project,  won top prize at  the  state
fair in Dallas last year.                                             <
   The  school  has  spent more than one million  dollars  on  the
project since 1975, when it began experimenting with grape-growing
near  the town of Van Horn in Culberson County and Bakersfield  in
Pecos County.                                                         <
   Kinney said the negotiations are at a stage which precludes him
from identifying any of the prospective bidders.  However, earlier
published  reports  have  indicated the university is  engaged  in
intense  negotiations with a subsidiary of Joseph Seagrams  and  a
group of Texas investors.                                             <
   It's a complex issue, particularly in view of the fact that the
new  winery will be privately owned,  but on university land.  But
estimates place the 1984 crop at about one thousand tons,  and the
university is intent on having a winery operation set up to handle
the crush of grapes.
```

Photo 10: *Wordstar's editing display with the main menu removed. (The main menu shows operations invoked by typing only a single control character.) You can choose one of four different degrees of user-prompting, ranging from continuous display of all menus through display of only subsidiary menus down to no user-prompting at all.*

The text here has been reformed into Wordstar's default mode, full right and left justification. On the screen, text is justified by insertion of full character-size spaces; on the printed output, from printers that can perform microspace incrementation, the text will be justified character by character.

Once in the edit mode, a new, main menu appears on the screen. Because typing ordinary characters inserts them into the text buffer, you access items on this menu by typing control characters—requiring two keystrokes, one to hold down the Control (Ctrl) key and the other to hit the letter key. Four of the command items in the main menu activate other menus containing less frequently used commands, so some functions (for instance, "move cursor to beginning of buffer") require striking three separate keys (including the Control key). The four submenus are called Quick, Print, Block, and On-Screen. If you have memorized which commands go with which combination of keys, you can type the keys fast enough so that the secondary menus never have time to appear on the screen, or you can give a command to prevent the menus from appearing on the screen at all. The cursor-movement control keys are grouped in an efficient arrangement around the left hand's home position; you can take the cursor anywhere without lifting your arm. (If you want to lift your arm, you can use the IBM's special cursor keys on the right.)

This structure makes a lot of sense to me and suits my working style (although my left little finger does get tired from pressing the Control key). But a lot of people complain that all those menus are confusing. If menus and control characters bother you, you'd better stay clear of Wordstar.

Part of the adaptation from CP/M-80 to the IBM PC was the assignment of many of the multikeystroke commands to the special-purpose or assignable-function keys on the IBM PC's keyboard. The cursor-pad keys were sensibly assigned, but I don't understand some of the assignments of F1 through F10. Keys are dedicated to functions like "set help level" and "set left margin" when functions that you need all the time, like "reform paragraph," are left out in the cold (or out in the menu). And there is no way I know of to change these assignments. Micropro doesn't even give you a function-key sticker.

The other famous characteristic of Wordstar is its screen-oriented print formatting. The popular description of this feature is "what you see is what you get," but in most cases this is not strictly true. The IBM PC's display adapters are not capable of replicating many of the variations of printing styles that a lot of today's printers are capable of producing, including 132-column output, microspace justification, expanded character sizes, italic fonts, and sub- and superscripts. So what you see is sometimes only a hint of what you get, and these hints often show up in the displays as embedded extraneous characters. (Wordstar does have a command to make these temporarily disappear.)

Screen-oriented print formatting is nice if you are doing short business letters, reproducible newsletters, and other documents that you will always want to print in exactly the same format you entered the text. However, if you have an article manuscript, as I often do, that you want to print in both single- and double-spaced versions, Wordstar's style of print formatting is a bother; you have to print one version and then go back into edit mode to

reform all the paragraphs, then print the second version. And even if you want only a double-spaced version to be printed, you might want to type in the text in single-spaced mode so that you can see more of it on the screen at once.

Another defect in Wordstar that shows up in similar circumstances is that you cannot use the search function to locate embedded printing-attribute characters. If you want to change all your underscored text to boldface, you have to search for it the hard way—by eye.

Wordstar encourages printing with even right and left margins (producing fully justified output) even on printers that cannot perform proportional spacing according to the width of characters (such printers are properly called "fixed-escapement," although Micropro calls them "Teletype-like"). As a result, a lot of Wordstar users routinely produce printed output that has been justified only by insertion of multiple full spaces between words. Such printouts look impressive at first glance, but they are actually harder to read than text that is printed flush-left, with a ragged right margin. Full justification should be set as a default condition only when the program has been customized to use a printer that can print in microspace increments. (This could form part of Wordstar's installation process.)

For all its versatility, Wordstar does not have some functions that would be useful. As distributed, it does not support the special printing attributes of the popular Epson MX-80 printer. (The MX-80's alter ego, the IBM Parallel Printer, can do the fancy printing only if the Graftrax-Plus option has been installed. There do exist ways to use the Epson attributes; see page 203.) Most of Wordstar's built-in printer options are for expensive formed-character (usually daisywheel) printers.

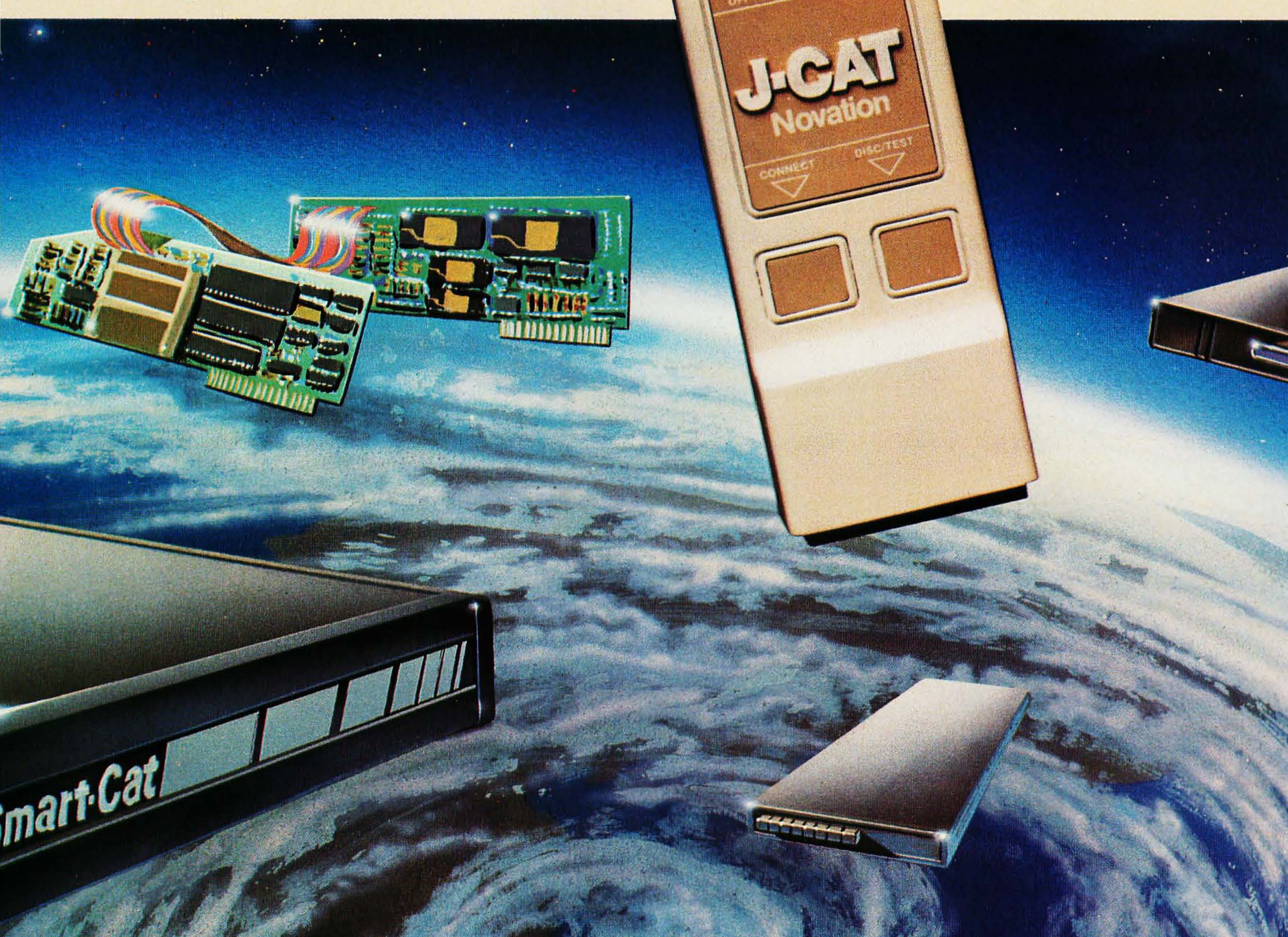
The default settings of most parameters cannot be changed by users. The program cannot use all the memory space available to the 8088 microprocessor—it must swap portions of the text of a long file to and from the disk. And to do any combining of files and interactive defining of the output text during printing, you must have the Mailmerge program at an additional cost.

The Final Word

This program is a product of Mark of the Unicorn, a software house that established its reputation with a product called MINCE, which gave to microcomputer systems an editor with most of the capabilities of the big-computer editor EMACS. (The name is a recursive acronym: MINCE Is Not Complete EMACS.) One of my discoveries in this project has been TFWINM: The Final Word Is Not MINCE. The two programs share a common heritage, many similar features, and even some code (in the C language), but there are differences in the organization of editing commands and in output facilities. (MINCE for CP/M-80 systems was reviewed in BYTE by Christopher Kern; see reference 4.)

The Final Word is an extremely flexible word-processing system. You can use it to effortlessly produce types of output that would possibly require great effort using any

Text continued on page 210



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Photo 11: *One of The Final Word's unusual features is the possibility of setting up two separate editing windows on the screen, with each window opening onto a different text buffer. Here the top window shows a portion of this article, while the bottom window shows a special buffer that contains the directory of one of the disks in the system. The white bar separates the two windows; the windows' relative sizes can be varied. You can also have as many as 12 buffers set up at once and switch between them with buffer commands.*

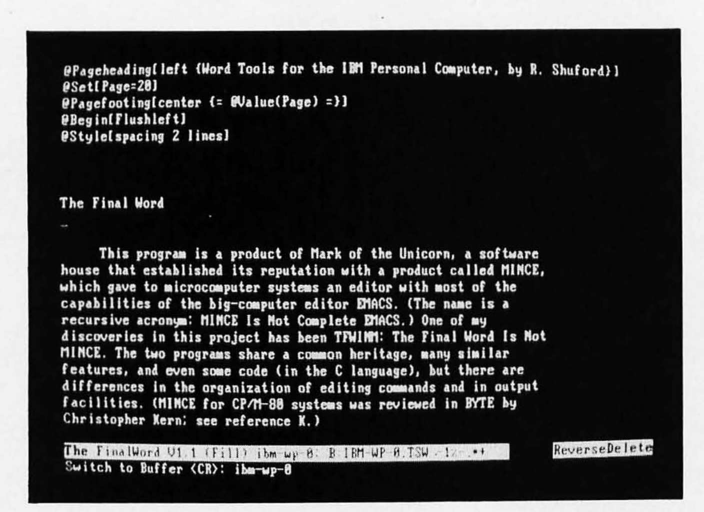


Photo 12: *The Final Word's normal editing display. Status information is shown in the next-to-bottom line in inverse video, with transient messages and user-command input on the bottom line. The text is displayed in normal intensity. (You can change the character video attributes by using the system-configuration utility program.)*

The five text lines at the top of the screen illustrate some of the embedded formatting commands used by The Final Word. These are interpreted by the formatting program and do not appear in the final output in this form.

Text continued from page 206:

other program. But with this great flexibility comes an extra measure of complexity. This program is more complicated than even Wordstar, but fortunately you don't have to learn every command and feature to productively use The Final Word. (One of the programmers for Mark of the Unicorn, Craig Finseth, described the concerns of the designers of the program in a BYTE article last year; see reference 2.)

At a Glance

Name
The Final Word

Type
Word-processing program

Manufacturer
Mark of the Unicorn Inc.
POB 423
Arlington, MA 02174
(617) 489-1387

Price
$300

Format
Two 5¼-inch floppy disks, PC-DOS (MS-DOS)

Language
C (source code not available)

Computer
IBM Personal Computer (as reviewed)

Documentation
User's manual: 402 pages printed with letter-quality printer in large loose-leaf binder; tutorial files on distribution disks; reference card; function-key chart

Audience
Users of word processing who need advanced features and extensive formatting capabilities

The Final Word has several unusual features including the following: You can view and edit two separate active documents (see photo 11), each in its own buffer and half-screen window, and you can transfer sections of text between the buffers. You can restore ("undelete") small segments or even large chunks of text that you have inadvertently or purposefully deleted. You can create files containing disk directories. And you can terminate execution of the program, do some other task with the computer, and then reactivate The Final Word to find your text buffers and even editing modes in place just as they were when you quit. This last capability is provided through information stored in the buffer-swap disk file, which also provides automatic protection against system crashes and interruptions. (Mark of the Unicorn calls this feature State Save.)

During editing, one special disk file, called FW.SWP, holds the swapped-out text from the currently used set of buffers. After you have stopped typing for seven seconds (or a duration you set), The Final Word automatically saves the segments of text you have changed and stores them on disk. This storage allows you to return to where you were after a power outage or other interruption with little trouble. You can set the size of this file according to your needs.

Some of the characteristics of The Final Word will seem strange to people who have been accustomed to some other editing system. For instance, block moves of text are accomplished by deleting the block, moving the cursor to where you want it to go, and then "undeleting"

the block. Anyone who has ever lost several hours' work on a computer system because of a careless erasure command *will* become quite nervous performing The Final Word's block-move procedure. (And you do have to be careful, because you can't do any further deletions to make room for the block at its intended destination without destroying it.)

In any attempt to rate word-processing programs by counting the number of commands, The Final Word would win hands down, at least in the group of programs reviewed here; there are nearly 160 different commands. It sounds like you could sink into a morass of control possibilities, but the program uses a logical series of menus to organize them. The structure of menu use seems somewhat akin to Wordstar's system, except that The Final Word goes one step further: three levels of menus for most commands, instead of two.

The most frequently used commands are assigned to single control characters (which you type with two keystrokes, of course). The two commands I used the most were the ones that change the direction of operation, either forward or backward. Most of the operations available in The Final Word proceed relentlessly in the selected direction. A set of commands select the operation that is to be performed, such as search for a string, delete an object forward, and delete ("kill") an object backward. Other commands select the text objects on which other commands operate. The objects are characters, words, sentences, lines, paragraphs, edges of lines, viewscreens, and buffers. (Does this remind you of Easywriter II? It's superficially similar, but the syntax is much more usable.) And some single control-character commands activate miscellaneous functions, such as "do the last operation again," "change the capitalization style of the word after the cursor," and "transpose the last two characters typed." This last command I found handy in correcting a common typographical error.

You type Control-X to cause a menu of menus to be displayed on the top section of the screen (see photo 13). You then type a character to select one of the submenus; when the submenu shows up, you type another character to activate the desired function. For instance, you can type Control-X to obtain the list of menus, then type "M" to select the Miscellaneous menu, and then type "Q" to select the Query Replace operation. As in Wordstar, if you type the commands fast enough, the menus don't show up on the screen. (The list of menus includes Buffers, Capitalization, Files, Help, Layout, Miscellaneous, Regions, Set, and Windows.)

If you don't like using the menus, you can use the function keys instead. And The Final Word has these in abundance, too. The directional cursor keys on the right work as you would expect (actually providing a mode of cursor movement not available through the Control-character functions). The Ins (insert) key works according to The Final Word's current mode.

Over on the left side of the keyboard, the assignable-function keys are used, consistent with the rest of The Final Word, in an exhaustive manner. First, ten functions are assigned to the unaided keys F1 through F10. Ten more functions can be invoked by holding down a *Shift* key while pressing F1 through F10. Ten more are available through combinations with the Control key, and ten more by using the Alt key. These 40 functions have been reasonably assigned by Mark of the Unicorn, but if you don't like the assignments you can change them yourself. If you like to use function keys, this surely gives you as many as are practical on the IBM PC.

But this is not for me. I can remember mnemonically assigned control-character functions, even through three levels of menus, much better than I can remember arbitrary associations of numbered keys. ("Hmm. . .let me see; Alt-F2 is 'turn fill mode on or off,' but *Shift*-F2 is 'place cursor at marker,' or was it the other way around?") You do get a reference chart describing the uses of all 40 functions, but I think very few people will bother to learn more than the unaugmented set of 10.

The documentation for The Final Word is more than 400 pages in a large loose-leaf binder. Most of these pages are a reference and installation guide, but the first 10 chapters are a comfortably paced set of lessons for inexperienced users. Some of the lessons use tutorial text files, provided on one of the distribution disks, to enable you to practice using a basic subset of the editing and formatting commands. And if you forget a command during an editing session, you can obtain an explanation of the use of most commands from an online help file.

In formatting output, you can use The Final Word the same way you use the other three programs we've discussed: make the text look the way you want on the video-display screen and transfer the document to the printer in that format. But there is another choice.

The Final Word has a powerful advanced-formatting facility that can be invoked through an advanced-print command. You can embed any number of special formatting commands in the text to obtain perfect formal output arranged spatially and typographically into chapter titles, enumerated indented lists, subheads, tables of contents, indexes, and even cross-references. The formatter can rejustify text according to specifications given at print time, automatically number items, produce headers and footers with section and page numbers, and print numbered footnotes. Character attributes may be switched easily, and proportional spacing can be obtained via microspace justification on printers capable of it. (A large number of printers are supported by the output routine.) The formatter can even invoke the inclusion of sections of text not in the active document, but stored in a disk file, and you can type in text from the keyboard during printing for inclusion in the output. Page breaks are not normally shown on the video-display screen, but you can request a "view" output from the formatter.

There are two prices to be paid for all this wonderful capability (besides the cost of the program). The first price is learning the complications arising from inserting format commands into the text. It will probably take you many hours and much experimentation to become proficient in using the embedded commands. Fortunately, the

commands are plainly recognizable in function: some typical commands are:

@Address[*text*]
@Majorheading[*text*]
@Style[Topmargin 6 lines]

There is even a @Verse format for those who are inclined to write poetry. Nonetheless, learning to write proper formatting commands is like learning to write programs for a FORTRAN compiler—error messages can suddenly come after the formatter has been running for three minutes, and you have to edit the file and start over.

The second price is the time required for the software to recognize and interpret all those embedded commands and the time needed by the formatter routine to process them. The time taken for The Final Word to do its housekeeping and begin printing a large document after you give the command can increase greatly when the formatter routine is called as part of the process. For instance, a 28,167-character file (last month's Ciarcia's Circuit Cellar) required 1 minute, 35 seconds for printing to begin without formatting; the duration jumped to 4 minutes with advanced formatting. If you want to format a lot of long documents, you'll find yourself taking a lot of enforced coffee breaks. But once the file has been formatted, you can start editing again as it prints. If most of your writing work involves producing documents with complicated structures, I think you'll gladly wait while the computer sorts it all out for you.

In addition to taking up time, the operation of the formatting routine also consumes a great deal of disk space. Unless you severely restrict your use of The Final Word, you'll need at least the disk space provided by two double-sided 5¼-inch floppy-disk drives.

Mark of the Unicorn, in contrast to Micropro International, allows you to customize your copy of The Final Word in a simple, menu-driven fashion. You can set up your preferred default conditions for editing and formatting parameters (such as indentation, tabs, preferred justification style, and page margins). You can define your own keyboard usage, binding functions to keys as you please. And if you need help, you can call or write Mark of the Unicorn.

Conclusions

The four programs I've discussed here are a representative sample of the word-processing programs available for the IBM Personal Computer.

Two of them are important because of their wide commercial success: the February 1983 issue of *Softalk for the IBM Personal Computer* (reference 9) ranked Wordstar as the best-selling IBM PC program during December 1982, with Easywriter II ranked eighth in the same survey. (Wordstar is also important because of its many good features. I can't speak so highly of Easywriter II.)

The other two programs are significant because of the value they offer in functionality: Volkswriter provides simple, easily understood word-processing capability at a

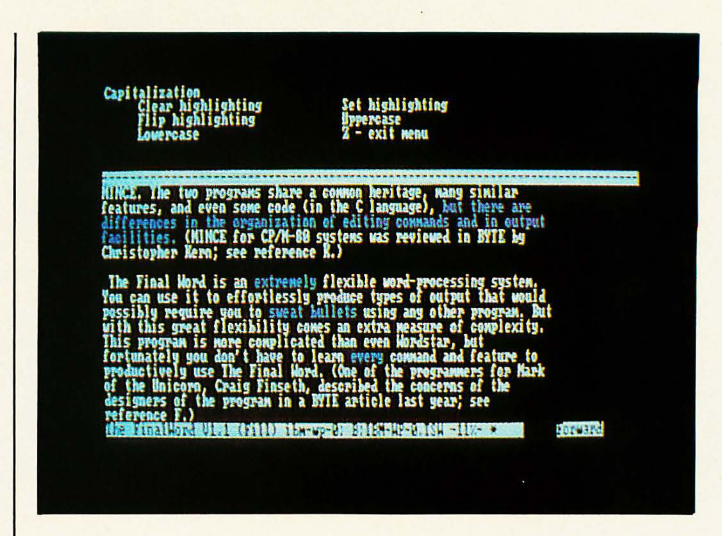


Photo 13: *When you type Control-X, a top-level menu of menus appears at the top of the screen. You then type a character (control or regular) to select one of the menu choices, such as the menu of Capitalization commands shown here. You then hit one more key to invoke the desired operation.*

This display, produced on an Amdek Color-II RGB (red-green-blue) video monitor, shows that portions of text designated to be highlighted on the screen show up in blue. Such highlighted text is underlined when the Monochrome Display Adapter is used.

relatively low price, while The Final Word, selling at a higher price, offers an amazing amount of flexibility for writing complex documents.

If I had to choose one of the four, I would probably buy The Final Word, because of its great flexibility, and yet there are things I don't like about the Mark of the Unicorn product. So I am still looking for the word-processing program of my dreams. In fact, I wrote most of this article using a fifth program I received too late to include in the project. So perhaps I'll be writing another review soon. In the meantime, consider your needs when you are choosing a word-processing program, and try before you buy. ■

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EASE-OF-USE By dividing programs into modules, JRT Pascal makes even very complex programs—of nearly any size—a breeze to manage. Pascal code is *self-documenting;* program sections are identified by meaningful names, not line numbers. Error messages are verbal, not number codes. JRT offers *12 data types* (to Basic's 2 or 3), and it has both regular and hex numbers.

POWER For power—the ability to write better, clearer programs, faster—*Pascal* is the run-away winner. Example: JRT simplifies programming by accomplishing complicated operations (for Basic) with one command:

Basic	JRT Pascal
IF A$ = "V" OR A$ = "W" OR A$ = "X" OR A$ = "Y" OR A$ = "Z" THEN...	IF A IN ['V'..'Z'] THEN...

FLEXIBILITY JRT's wide variety of data types reduces programming restrictions. And the data types are not all fixed in size. There are *3 looping statements* (Basic has 1). With JRT, very large programs can be created and run, because program modules can be spread over many diskettes. Common modules can be used for several programs. Basic generally limits strings to 255 bytes; *JRT strings go up to 64K.*

EFFICIENCY Whereas Basic relies on a static, inefficient memory map to allocate storage, JRT's *dynamic storage* fills every available main storage area; there's no waste. With Basic, sub-routine modules must be linked together; with JRT, they can be linked—but don't have to be. JRT's more powerful commands run faster; typically, you'll *write Pascal programs 3 to 10 times faster* than in Basic. *Exclusive:* JRT lets you directly access the CP/M* operating system for better total system control.

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CASE statement	No	Yes
Introduced	1965	1980
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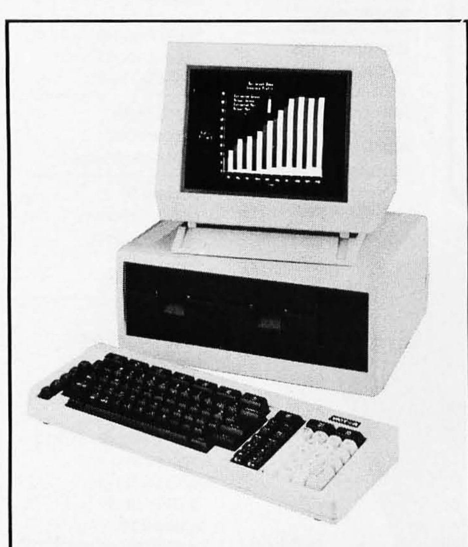
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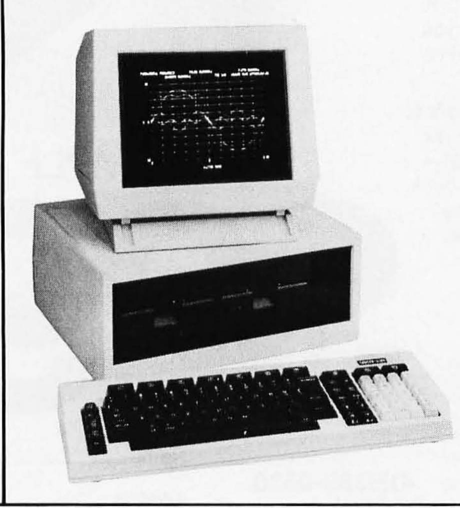
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A Comparison of Five Database Management Programs

Actual field use uncovers surprising results.

Jack L. Abbott
8525 North 10th Ave.
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Database management systems, or DBMSs, are general-purpose programs that accept data in a format that you determine, process the data according to your requirements, and then output the data in the report format that you specify. While a review of such a program may tell you about its major features, only by comparing several DBMSs can you determine which program best fits your needs.

A good DBMS should fill the gap between a custom-designed application program and an off-the-shelf general-purpose package. I designed a comparison test of five DBMSs around that specification. I looked at the Selector V by Micro-Ap Inc., dBASE II by Ashton-Tate, FMS-80 by Systems Plus, Condor III by Condor Computer Corporation, and Analyst and Qsort by Structured Systems Group. By using an actual inventory file maintained by two jewelry stores as test data, I uncovered some significant differences in these programs.

Essentially, DBMSs perform four functions: data input, selection and sorting, processing, and report output. The comparison test included all these functions. In table 1, you see a typical example of the data-input format used to maintain the inventory for the two jewelry stores. The two stores have a total of 1007 different types of jewelry pieces with varying quantities of each type. The data-input format consists of 15 descriptive items or fields about each different piece of jewelry. The complete description of one piece of jewelry requires a total of 128 characters (bytes) and is called a record. The 1007 records make up the inventory file. This file occupies between 135K and 155K bytes of disk storage depending on the storage method used by the particular DBMS.

After establishing the input format, I displayed this information on the screen. The display is similar to that of table 1, except that blank spaces are provided after each field name so the inventory data can be typed in for each record. After entering the jewelry stores' inventory data, I translated the jewelry-store file to the individual formats of the five DBMSs. I used the file as a benchmark to compare these programs.

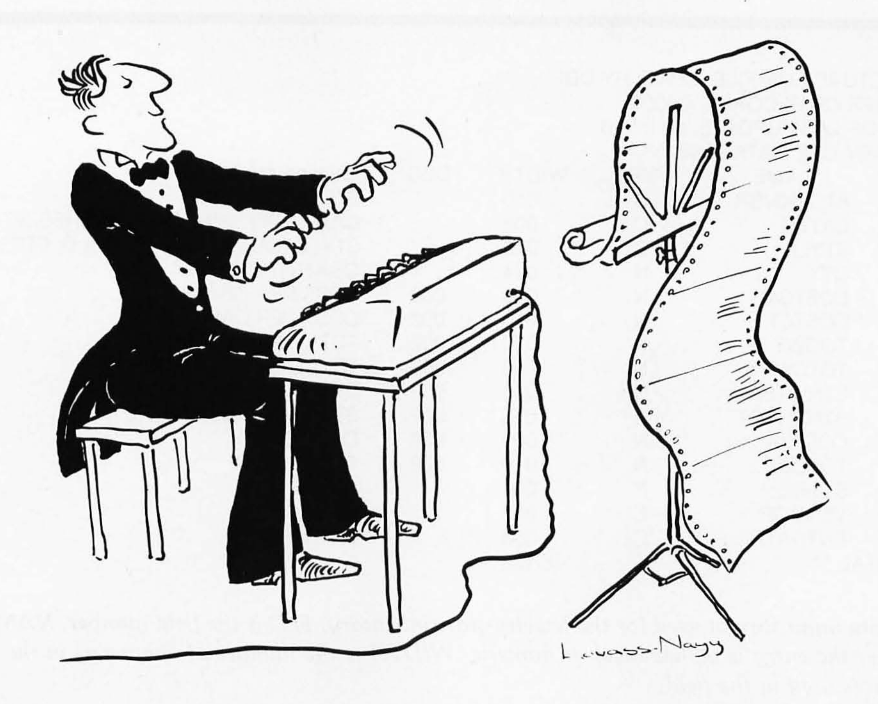
Data-input functions include defining the structure of the records as shown in table 1. Custom input screens may also be generated by some of the DBMS programs. Instead of the columnar input format, a custom screen permits placement of identifying labels and adjacent blank spaces where you can type in the field information. An example is a screen display of a purchase-order form. You enter the order data into the blank spaces of that form for each field in the record. The DBMS then saves the data for subsequent processing.

The second function is selection and sorting. Let's assume that, after all the jewelry store inventory data has been entered, you want to find all individual records that pertain to rings. The most effective way is to first either sort or index records on one or more selected fields. Sorting a file aligns all the records in ascending or descending order based on the alphabetical or numeric values in one field. Indexing a file accomplishes almost the same result but requires much less disk storage space because only a single selected field of a record (with an index pointer to the full record) is sorted.

In my example, the CATEG (category) field of each jewelry-file record tells whether the record pertains to chains, rings, watches, brooches, etc. To find all the ring records, you ask the DBMS to sort or index the file, placing each record in alphabetical ascending order based on

About the Author

Jack L. Abbott was previously manager of systems programming at Philco Western Programming Development Laboratories in Palo Alto, California. He is now a consultant and owner of the Software Center, a software store, in Glendale, Arizona.



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```
STRUCTURE FOR FILE: JEWELRY.DBF
NUMBER OF RECORDS: 00000
DATE OF LAST UPDATE: 00/00/00
PRIMARY USE DATABASE
FLD      NAME      TYPE   WIDTH   DEC   Explanatory note:
001   STOCKNBR      C      010          STOCKNUMBER
002   CATEG         C      008          CATEGORY (RINGS, BROOCHES, ETC.)
003   STYLE         C      010          STYLE (LADIES, MENS, GOLD, ETC.)
004   QTY           N      004          QUANTITY
005   COSTGM        N      010    002   COST PER GRAM
006   COSTCT        N      010    002   COST PER CARAT
007   TOGWT         N      010    002   TOTAL GRAM WEIGHT
008   TOTCWT        N      010    002   TOTAL CARAT WEIGHT
009   STNWTEA       N      010    002   STONE WEIGHT EACH
010   STNWTTOT      N      010    002   STONE WEIGHT TOTAL
011   COSTEA        N      009    002   COST EACH
012   TOTCST        N      010    002   TOTAL COST
013   STORE         N      001          STORE
014   VENDOR        C      007          VENDOR
015   ENTDATE       C      008          ENTRY DATE
** TOTAL **                00128
```

Table 1: *Example of data-input format used for the jewelry-store inventory. FLD is the field number, NAME is field description, TYPE describes whether the entry is alphabetical or numeric, WIDTH is the number of characters in the field, and DEC is the number of decimal places used in the field.*

a comparison of the alphabetical values in the CATEG field.

After the data file has been sorted or indexed at your typed-in request, the DBMS will rapidly run through the file or the index and select all the records in the rings category. At your option the selected records are then either displayed, printed, or placed in a separate file for further processing.

For the third function, processing, you tell the DBMS to perform specific operations on the selected records. Using the ring example, let's say you want to record a 20 percent price increase for all rings. First, you ask the DBMS to divide the COSTEA (cost each) field of every ring record by .80 to reflect the 20 percent price increase. You then multiply the QTY (quantity) value by the COSTEA value and store the result in the TOTCST (total cost) field. You can perform similar mathematical operations on any fields in the record.

The fourth function, output, may be a simple listing of the selected data or a more elaborate presentation, including statistical summaries, subtotals, and totals on a formatted page report. The more sophisticated DBMSs include report output generators that make it possible for you to print your data output as mailing lists, checks, purchase orders, invoices, or in any desired format.

DBMS designers use two general methods for function selection. One method displays a list of general functions as soon as the DBMS starts to run on the computer. From this list, or menu, you select a submenu that expands your selected function into a detailed list of tasks. The second method presents you with a blank screen after the DBMS is loaded. You must initiate the DBMS directly, using its commands individually, or through a command file. A command file is simply a series of DBMS commands written in sequence. You use a single initiating command to execute that entire sequence of commands. The sequence may include commands to accomplish specific tasks or to display Help information and menu selections.

Ideally a DBMS should handle any application. In actuality design trade-offs occur, making some DBMSs more effective than others for a given application. The jewelry-store inventory, for example, has only one relatively short data file, but it must be accessed and updated as quickly as possible. An important characteristic of a DBMS for a jewelry-store inventory would be speed. In another application (for example, when processing personnel records), the DBMS must readily access several different files (such as payroll, hiring, and job performance information). Information may be required about one person from many files, a number of people from one file, or a number of different people from a number of different files. The DBMS must provide data from all these files with reasonable speeds, but definitely not the rapid access required by the inventory application. Additionally, the DBMS that processes personnel records must handle longer record lengths and a larger number of files than a DBMS that handles inventory data. Hierarchical or network DBMSs are better for simultaneous, multiple-file access while relational DBMSs are most efficient when extracting data from one file at a time.

Data Storage Requirements

For each of the five DBMSs discussed here, you should have available two disk drives with (depending on your application) a minimum capacity of at least 300K bytes per drive. (Table 2 presents the system requirements for each of the DBMSs plus the maximum number of records, file size, and record length that each DBMS will handle.) As I mentioned earlier, the example jewelry-



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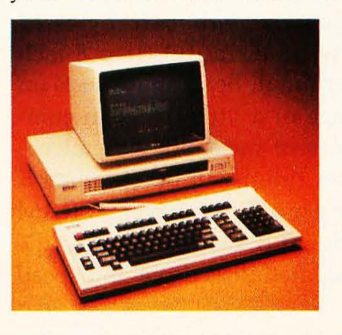
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DBMS	Program Version	Operating System (8 bit)	Operating System (16 bit)	Memory Requirements (in bytes)	Maximum Records Per File	Maximum Record Length (in bytes)
Analyst and Qsort	2.0	CP/M and MP/M	not available	48K	65,535	255
Condor III	2.09	CP/M and MP/M	MS-DOS and CP/M 86	56K	32,767	1024
dBASE II	2.3B	CP/M and MP/M	MS-DOS and CP/M 86	48K (16-bit version: 128K)	65,535	1000
FMS-80	2.21D	CP/M and MP/M	not available	56K	65,535	20K+
Selector V	1.04	CP/M and MP/M	MS-DOS and CP/M 86	56K	65,535	25,245

Table 2: *Statistical information about each database management system. Figures in the table list the maximum length and number of possible records, but the disk configuration of your system will determine the maximum number of files.*

store database file of 1007 records occupies from 135K bytes to 155K bytes of storage on a disk depending on the disk storage format. Each time you sort the file on a different field, an additional equal amount of storage is required. Indexing a file is similar to sorting but requires much less disk storage space. In the jewelry-store example, a median disk storage requirement for an index file on the CATEG field is 35K bytes. This figure will vary depending on the number of characters in the indexed field.

While not absolutely necessary, it is desirable to have the DBMS and required CP/M utilities on one drive and the data file on another. Compare my example file with your own intended application. Consider that if I keep all the jewelry file data on one drive, the example file will occupy 135K bytes, and with one additional sort the files will occupy a total of 270K bytes on a typical 320K-byte system drive.

Analyst and Qsort are written in CBASIC2, but a runtime interpreter is furnished and need not be purchased separately. FMS-80, dBASE II, and Condor are written in assembly language. Selector V is written in compiled CBASIC2. Assembly-language coding is the fastest and most efficient, followed by compiled CBASIC, with interpreted CBASIC the slowest. The compiled CBASIC program Selector V performs some functions more rapidly than assembly-language-coded programs. However, assembly-language-coded programs require less memory and disk storage space.

Timing Comparison

Table 3 shows how the five DBMSs fared in timing tests that were run on a Dynabyte 8/1 8/4 Z80 microcomputer running at 4 megahertz with 64K bytes of RAM (random-access read/write memory), two 8-inch drives, and a Televideo 925 terminal. Benchmark tests on this machine place it as average or a little better in comparison to the processing times of most popular microcomputers. Significantly better times will be obtained if you have a hard-disk drive or use a RAM drive. (A RAM drive is a program and additional RAM that look to the computer like a very fast simulated disk drive and speed up processing greatly.)

Now let's consider some of the factors influencing the test results for each of the five DBMSs:

Analyst and Qsort ($350 from Structured Systems Group, 5204 Claremont, Oakland, CA 94618; (415) 547-1567): The longer times required for this DBMS to load individual menus are a result of its being written in interpreted CBASIC2. Once the menus are reached, processing times are very fast. This program does not have file indexing. A sequenced file is obtained by sorting. The disadvantage is that a sorted file takes up as much disk storage space as the original file. Its file-sort time is the best of the five DBMSs. Times to locate a record after the sort is finished are comparable to indexed files.

Condor III ($995 from Condor Computer Corp., POB 8318, Ann Arbor, MI 48107; (313) 769-3988): Because this DBMS is written in assembly language, the time required to bring up the program or to switch from one function to another is 2 or 3 seconds. There is no menu, but you can easily construct one using a command file and the supplied screen-display generator. Condor will sort a 128K-byte file in 3 minutes and 30 seconds. By chance, the jewelry file is 128K bytes. To sort a file over 128K bytes in length, you must split the file into sections and then sort each section. The individual sections must then be recombined. This is a time-consuming and somewhat complex procedure and is a serious deficiency if you plan to generate large files. (The latest version of Condor is now able to sort files larger that 128K bytes.)

dBASE II ($700 from Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230; (213) 204-5570): Like Condor, this DBMS does not have menus for the individual processing tasks. The program will load and be ready for operation in 2 or 3 seconds. You must remember the commands to implement the program's functions. As an alternative, it is a simple matter to use the supplied screen display generator to construct a command file help menu. You can request the help menu to be displayed at the outset. Command file menus can also be generated to select groups of sequenced commands.

The most significant deviation from the other four DBMS processing times is listed in comment 5 of table 3. It took 1 hour and 21 minutes to delete 50 records from the database and re-index the file on one field. This is not as serious as it might first appear because records are first marked for deletion but are not permanently erased until

Maximum Fields Per Record	Maximum Field Length	Digits of Accuracy	Screen Editing
50	255	14	line oriented
127	127	10	fully addressable cursor
32	254	10	fully addressable cursor
255	255	10	fully addressable cursor
99	255	14	fully addressable cursor

a pack operation is accomplished. Marking the record for deletion takes little time. It is simply a matter of finding the record in the file and then marking it. Records can generally be located within a few seconds. After the record is marked it will be ignored by the program for most processing or selection tasks. To complete the process and regain the disk storage space used by the deleted records you must then execute a pack command. Next the file must be rewritten to the disk to condense the CP/M disk file. The records can be marked for deletion during normal operations and then at night or during a slack period the pack operation and file rewrite can be performed.

FMS-80 ($990 from Systems Plus, 3975 East Bayshore, Palo Alto, CA 94003; (415) 969-7047): This DBMS has menus for each function. It is written in machine language and the times to bring up the various menus are short. It took 15 minutes to merge and re-index the file after entering 50 new records. This is longer than the time taken by the other DBMS programs to perform this function. In addition, each time you first ask FMS-80 to find a record by searching the index file, it responds, "please be patient, re-establishing index file." This took another 25 seconds with the jewelry file. Subsequent searches take only 2 or 3 seconds to find a record. A very good feature not reflected in the timing charts is the capability to modify (but not delete) records directly from the index file. This can be accomplished in seconds. This may explain why the file must be reestablished each time it is used.

Selector V ($495 from Micro-Ap Inc., 7033 Village Parkway, Suite 206, Dublin, CA 94568; (415) 828-6697): The times for Selector V, a compiled CBASIC2 program, to bring up its menus are much shorter than those required for Analyst and Qsort, an interpreted CBASIC2 program, and are comparable to those of FMS-80, a machine-language program. The times to go to the different functions of Selector V are very good indeed.

Distinguishing Features

Of course, there's more to a database management system than storage requirements and execution times. Now I'll discuss the individual systems in terms of those features that set each DBMS apart from the rest.

Analyst and Qsort: Program functions are selected from menus. Times to load program modules to accomplish different functions are slower than for the other DBMSs. This may not be a handicap if a number of records are processed at a time. After a function menu has been displayed and the program module loaded, processing execution times are excellent. File indexing is not available. The same results are obtained by sorting the file. Logical selection times for individual records or groups of records are as short as for indexed files. Qsort can be used as a stand-alone program to sort data generated by other programs. Report outputs are limited to six lines for each record unless the program structure is modified. This permits mailing-label generation but limits the output formats available to forms less than six lines in length. Analyst always puts in a form-feed prior to starting a report.

Command-file generation procedures are not available. Report output procedures are complex to establish, but the descriptive documentation is excellent. To use any of the CP/M operating-system commands, you must exit the Analyst program. This is the lowest-priced of the DBMSs reviewed and should be considered if it can accomplish your application.

Condor III: This DBMS has an excellent screen and report generator. Although Condor, dBASE II, and FMS-80 all include a programming language for generating command files, the Condor programming language is the easiest of the three to learn. Indexing can be automatically accomplished on one field after new records are entered. Condor is especially well suited for accounting applications because a number of commands are tailored specifically for that use. Every time that you bring up Condor, you must enter a six-digit serial number, otherwise the program will not perform properly. I don't like this feature because it takes time and is nonproductive. A major drawback of this DBMS is the limitation of not being able to sort files over 128K bytes in length without dividing and then recombining them. This is particularly annoying because it is necessary to sort a file to permanently remove deleted records. An outstanding interface is maintained with CP/M, and any required operating-system commands, including calling up disk directories, are available without leaving the DBMS. Command files can be generated that enable the program to perform sequenced commands or display a user-designed menu with only one command entry. In the processing area, Condor DBMS has no mathematical precedence established and does mathematical operations in the same order they are entered. Fractional results will always be rounded off to two decimal places. The Condor documentation is good, but it would be helpful if examples of more applications were included.

dBASE II: One of dBASE II's strongest points is its ability to access a data file rapidly and to find and display or print out single or groups of logically selected records with a minimum of operator direction. Simple application programs can be easily generated by the newcomer to computing. For more complex applications, the

Program Operation or Function	Analyst and Qsort	Condor III	dBASE II	FMS-80	Selector V
1. Time from when initiating command is typed in until database main menu is displayed or until the database is ready to accept commands if there is no menu.	35 sec.	3 sec.	3 sec.	28 sec.	18 sec.
2. Time to go from main menu, or time until database program is ready to accept commands to examine, edit, or enter data.	30 sec.	3 sec.	3 sec.	5 sec.	5 sec.
3. Length of time to return to the main menu from data examine, edit, or enter-data function.	15 sec.	3 sec.	3 sec.	5 sec.	5 sec.
4. Time required to accept, merge, and sort or (where applicable) re-index on one field 50 records into the 1007-record test inventory file. Does not include time required to type in the record data.	2 min. & 50 sec.	3 min. & 45 sec.	3 min. & 25 sec.	15 min.	1 min.
5. Time required to delete 50 records from the 1007-record test file. This includes cleaning up and compacting the file after the records have been marked for deletion but does not include the time required to mark or select the records for deletion.	20 min.	7 min. & 30 sec.	1 hour & 21 min.	11 min. & 40 sec.	1 min. & 20 sec.
6. Time required to sort the 1007-record inventory example file on one field. All the records are aligned in alphabetical order based on the information contained in one field.	2 min. & 46 sec.	3 min. & 30 sec.	14 min. & 30 sec.	12 min.	3 min.
7. Time required to index the 1007-record file on one field.	not applicable	3 min. & 30 sec.	3 min.	4 min.	4 min.
8. Time to find a single record by key search with the record located at the other end of the 1007-record file from where the search is started.	3 sec.	3 sec.	3 sec.	3 sec.	3 sec.
9. Time required to extract 50 selected records spaced equidistantly throughout the 1007-record file.	6 min. & 30 sec.	20 sec.	3 min.	4 min.	2 min. & 30 sec.
10. Time required to go from the main menu or from when the DBMS is ready to accept a command to the start of printing a selected report.	25 sec.	3 sec.	3 sec.	6 sec.	18 sec.
11. Time required to return to the main menu after the report is printed.	15 sec.	3 sec.	3 sec.	6 sec.	8 sec.

Table 3: *Comparison of times required for the Dynabyte 8/1 8/4 microcomputer to perform the tasks listed in the left column. Don't place too much emphasis on speed. It is only one of the criteria involved in choosing a database management system for your needs.*

dBASE II programming language is flexible enough to accomplish almost any application. This may sometimes cause problems for the new user. Because so many options are available, learning the program commands can be difficult. For most applications this is preferable to sacrificing capability in favor of a less complicated program. Command files can be generated using the programming language. The current version of dBASE II includes a screen-display and report generator subprogram called ZIP. ZIP works well but has the annoying attribute of sounding the terminal alarm whenever a command is entered to tell the program to do something.

With the exception of the length of time required to pack the data file after deletion of records, this DBMS accomplishes all applications very well. Like Condor, it interfaces well with CP/M. Command files can be generated as well as custom menus.

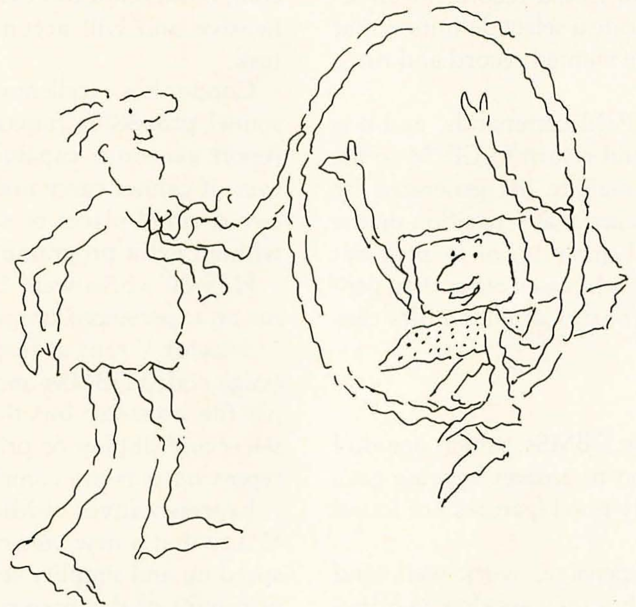
All DBMSs should be able to use files generated by other programs; dBASE II transfer procedures for files with different formats are easier to use and more effective than any of the other DBMS programs. This transfer procedure is used so that data to be processed by dBASE II can be transferred to or from other programs running under CP/M such as Wordstar or CBASIC2. Its data-handling capabilities make dBASE II the most nearly satisfactory of the five DBMS programs for a real-time application.

The documentation is reasonably well done. If you are a new user I recommend you obtain Robert A. Byers's *Everyman's Data Base Primer Including dBASEII* (available for $16.95 from Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230). It lists several programs, including a mailing-label program. Simple step-by-step instructions on how to design and use the programs are included.

FMS-80: Like Condor and dBASEII, this DBMS is written in assembly code, but unlike the others, it has menu selections for the different functions. Command files can also be generated. The CP/M interface to run CP/M commands is limited when compared with Condor or dBASE II. A formatted report capability is available but it is complex to set up. Initial setup of the applications programs developed with FMS-80 should be done by someone with a programming background. Adding new records to a file is time consuming in comparison with the other DBMSs. The documentation should be expanded to better explain a number of program functions, including report generation.

Selector V: This DBMS and Analyst each come close to the classic definition of a network or hierarchical DBMS, as opposed to the other three, which may be loosely defined as relational. Data can be extracted from multiple files more easily with a hierarchal than with a relational DBMS. Accessing multiple files with a relational data-

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base can be done easily only by using command files. Even so, most of the newer DBMSs are relational due to the added complexity of the hierarchical or network type.

As indicated on the timing charts, Selector V, written in CBASIC2 and then compiled, compares favorably with the machine-language DBMS in running time. Report generation using Selector V is complex, even though the documentation is, for the most part, well written. It is time consuming to find a record not in sequence in a file. You must generate a select definition that defines the characteristics of the wanted record and run a search subprogram.

There is no interface with CP/M commands, and it is necessary to leave Selector V and return to CP/M to list the directory. When using a mailing list generated by Selector V, there is no way to start at any position on the mailing list other than at the beginning, or to pick out and print individual names and addresses other than generating a separate individual report. Command files cannot be generated.

Summary

After doing the tests on these DBMSs, which one do I prefer? This is a tough question to answer because each individual DBMS has some very good features not found in the others.

Analyst and Qsort are inexpensive, work well, and have excellent documentation, but they are slow in bringing up program menus and have limited report-output capability. Qsort can be used as a stand-alone program to sort any type of file.

The dBASE II system can select, edit, manipulate, and display or print any record or groups of records in a file easily and quickly. Simple application programs are very easy to accomplish even for an inexperienced computer user. The dBASE II programming language is somewhat complex and not too easy to learn, but it is very comprehensive and will accomplish almost any programming task.

Condor has excellent capabilities for accounting or personnel processing functions, an outstanding screen and report generator capability, and is easy to learn. However, it cannot carry mathematical operations to beyond two decimal places or sort files longer than 128K bytes without extra programming effort.

FMS-80 works well, but is quite complex to use even for an experienced programmer.

Selector V runs as fast or faster than the assembly-language-coded DBMSs and has definite strengths in multiple file accesses, but the current version cannot easily select and display or print groups of records. Formatted report outputs are complex to generate.

Representatives of Micro-Ap, the producer of Selector V, say that a new version will soon be released that will speed up and simplify selection and display of individual or groups of database records.

If cost were not a limiting factor I would prefer Condor for accounting applications and dBASE II for other programs. For overall effectiveness, my selection is dBASE II. I would accompany it with Quick Code, a screen-display, report, and automatic-code generator (available for $295 from Fox and Geller, POB 1053, Teaneck, NJ 07666). Designed specifically to supplement dBASE II, Quick Code greatly simplifies the use of the programming language and furnishes an effective screen and report generator.

I have spent many hours working with these DBMS programs. A lot of effort has gone into their development, and it shows. The combined documentation for the five DBMSs totals well over 1000 pages. I have pointed out some weak points in all of these systems, but if you compare the expense of buying a DBMS with the effort and study required to write your own application program in assembly language or a high-level language (BASIC, Pascal, etc.), you'll find that any of these DBMSs can provide good value for the price. ■

For more information on the database management systems (or their predecessors) discussed in this article, see the following reviews by Jack L. Abbott: "Analyst and Qsort by Structured Systems Group" (January 1983 BYTE, page 346), "Condor Series 20 DBMS" (December 1982 BYTE, page 404), "Database Management with Ashton-Tate's dBASE II" (July 1982 BYTE, page 412), "Selector IV by Micro-Ap: An Information-Management Program" (April 1982 BYTE, page 371), and "Systems Plus: FMS-80" (October 1982 BYTE, page 446).

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Bazic
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Stalking the East-Asian Microcomputer

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Although the products of Asia's modern technologies do not yet rival its ancient treasures, they soon will. The five-nation Far East Electronics Tour in October and November 1982 delivered this message to one group of Americans through a series of six electronics trade shows: the Japan Data Show and the Japan Electronics Show (both covered in the first part of this article, "New Japanese Microcomputers," April BYTE 1983, page 110), the Korea Electronics Show, the Taiwan Electronics Show, the Hong Kong Consumer Electronics Show, and China Comm 1982, in Beijing. Firms in all these countries except China manufacture microcomputers of local design.

The first stop on the tour was Japan, where the trade shows exhibited the most significant new microcomputers and where a remarkable Tokyo neighborhood showcases the vigor of the domestic Japanese microcomputer market. The rest of the tour revealed interesting developments in the other countries as well. (For those who are thinking of joining the 1983 Far East Electronics Tour, the organizer is Commerce Tours International, 870 Market St., San Francisco, CA 94102, telephone (415) 433-3072.)



Photo 1: *Yamagiwa Tecnica, a six-floor store in Akihabara, Tokyo, sells only microcomputers and associated products.*

Akihabara, Tokyo, Japan

If the object is electronics, then every tour of Asia should begin and end in Akihabara. This remarkable neighborhood in Tokyo is as interesting as the Japanese electronics shows. Akihabara (pronounced with the accent on the third syllable) covers an area of several square blocks. More than 400 electronic shops of varying size are packed into buildings about five to eight stories high. Escalators take you from the middle of one shop and drop you into the middle of another. There are probably more shops selling microcomputers and related products in Akihabara than in any other neighborhood in the world, except perhaps in Osaka, the great industrial city that boasts a neighborhood called Nipponbashi said to rival Akihabara.

Many scenes in Akihabara strike the Western eye as improbable: a man riding a bicycle with an NEC PC-9801 16-bit computer strapped on the back fender; a shop with bins full of a remarkable hybrid device, a combination electronic calculator and mechanical abacus; integrated-circuit shops packed with customers of all ages and pocketbooks standing side by side poring over the latest chips; a

Photo 2: *A no-frills electronics store in Akihabara.*



Photo 3: *Typical Akihabara store display.*



Photo 4: *The Samsung SPC-1000 Z80A-based home computer from Korea.*



Photo 5: *The thronged exhibit booth of the Multitech Industrial Corporation at the Taiwan Electronics Show.*

storefront full of oscilloscopes and logic analyzers arranged to grab the eyes of potential customers.

Some of Akihabara's larger stores sell all kinds of Japanese-made electronics—audio, video, music, home appliances. Each devotes an entire department to microcomputers; often a whole floor is packed with machines from most of the major Japanese manufacturers.

Some large stores—notably Yamagiwa Tecnica, shown in photo 1—sell microcomputers only. Yamagiwa Tecnica has six floors: one devoted to software, another to home computers, another to more powerful computers (mostly 16-bit), word processors, and so on. The one-floor NEC Bit-Inn has nothing but NEC machines ranging from the PC-2001 hand-held computer to the N5200 (known in the U.S. as the Advanced Personal Computer) and the PC-9801, both 16-bit computers. Expansion boards and accessories for these computers are in stock. Another store, shown in photo 2, offers no frills but good prices on boxed computer products, mostly from NEC. Customers walk where they can, mostly behind the rows of boxes. Typically, the interiors of the retail computer stores are packed with equipment on display. Photo 3 shows a section of a typical store interior.

Many small stores in Akihabara specialize in various kinds of components. One storefront devoted to semiconductors was selling 64K-bit dynamic RAM chips at 8 for 9000 yen, or about $4.25 per chip. (The lowest price I've seen in this country is $5.50 per chip, from a mail-order firm.) Customers had the choice of NEC, Mitsubishi, or Toshiba RAMs. The man behind the counter complained that 64K-bit RAMs were in short supply, which led me to believe that the prices were probably no lower than usual. Another small shop sold disk drives, power supplies, single-board computers, circuit cabinets, and the like.

Many of us foreign shoppers were concerned about the reliability of these low-priced goods. Were we being offered factory rejects? A Japanese businessman allayed our fears, saying there was no need to worry about getting defective goods in Akihabara. If a Japanese electronics manufacturer discovered that defective goods bearing its name were being sold by any shop, the company would never again deal with that shop. In effect, the manufacturers police the retail trade.

The neighborhood was so much like a bazaar that I found the impulse to haggle irresistible. But I was worried: Would haggling be possible when I spoke no Japanese and the shopkeeper spoke almost no English? Would the concept of bargaining be clear? Would the shopkeeper find bargaining offensive? Could he recognize the English words for numbers? At last I ventured to ask, "Discount?"

The shopkeeper replied, "Target price?" and handed me a pad and pencil. The list price was 120,000 yen, then worth about $450. I wrote, "90,000." The shopkeeper laughed pleasantly and wrote, "100,000." We soon reached agreement on a price of 96,000 yen. A NEC memory board for the Advanced Personal Computer with a list price in the United States of $700 then changed hands in Akihabara for only $362.

A NEC memory board costs $700 in the United States but sells for $362 in Akihabara.

The flourishing electronics industry that makes Akihabara possible has in part resulted from efforts of the Ministry of International Trade and Industry (MITI). Because MITI's Industrial Electronics Division funds research, some Americans have charged that Japan's electronics manufacturers enjoy an unfair advantage in competing with American manufacturers. Toshio Takai, who worked in MITI for 25 years before becoming executive vice-president of the Electronic Industries Association of Japan, denies the charge. He says, "MITI funds only basic research, and MITI's research money cannot be used for development of commercial products." Takai also points out that there is nothing to stop the government of the United States from funding research in electronics as MITI does in Japan.

Seoul, Korea

Our introduction to the Korea Electronics Show was unlike what we encountered elsewhere on our journey. As my group arrived at the trade center, we saw dozens of black sedans that formed a semicircular barricade in front of the exhibition hall. Perhaps a hundred men in dark business suits, some holding handguns, arrayed themselves behind the barricade. All the Koreans who approached the exhibition hall were stopped by these guards, but Westerners could pass through. In addition to the guards, the only Koreans inside the barricade were old women stooping over crude short-handled brooms, sweeping every speck of dust from a wide path leading to the entrance of the hall. As we watched, several more black sedans arrived and passed through the barricade to park in the protected semicircle. More guards emerged from the newly arrived cars. All the guards now appeared poised for action, their eyes watchful. One guard opened the rear door of a car and out stepped a lone man in a dark business suit. All eyes followed that lone man as he walked down the clean-swept path and disappeared into the hall. "The President," someone said.

Inside, exhibits of consumer electronics and components and a few Korean microcomputers vied for our attention. Photo 4 shows the Samsung SPC-1000 home computer, a Z80A-based machine with a 32K-byte ROM containing Samsung-HuBASIC, 70K bytes of RAM, a music and sound generator, and an audio cassette built in for mass storage. Samsung also makes the Samsung Personal Computer, the SPC-2000. It is a 64K-byte CP/M-based system with dual 5¼-inch floppy disks, a detached keyboard with programmmable keys, and a video monitor that tilts and swivels. Gold Star, Taihan, DMS, Trigem Computer, and a few other companies also displayed microcomputers.

The Trigem 20 is a 64K-byte Apple look-alike with a 12K-byte BASIC in ROM (read-only memory). The Trigem 20 has sound and color-graphics capabilities, game input/output, and eight empty expansion slots as standard equipment. Company spokes-

The Japanese Microcomputer Marketplace

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Over the past four years Japanese microcomputer manufacturers have seen their share of Japan's domestic market increase from 10 to 75 percent. Clearly, advances in technology and marketing techniques make this the market to watch throughout the decade.

Almost every Japanese electronics company, large and small, is in the personal computer business. Fierce competition is seen in all price ranges as each firm attempts to carve its own market niche. A great boon to consumers, the lively market is producing microcomputers that come fully equipped with features hardly imaginable just a few years ago when Apple and Radio Shack dominated the Japanese market. By following the competition's footsteps, the Japanese are able to offer compatibility with existing hardware and software plus improvements in reliability, service, features, and price. As an added advantage, many companies supply themselves with semiconductor chips and have their own well-established distribution networks.

Today's typical Japanese microcomputer usually has a Z80 microprocessor and offers a variety of standard features such as separate numeric keyboards, programmable function keys, selectable 40- or 80-character displays and Japanese or graphics character sets. Each company tries to include a feature in its machine that sets it apart from the competition. For example, some of the newer VLSI chips like the 64K-bit RAMs are appearing in many computers. Additional features seen recently include bubble memory, plug-in ROM packs, built-in terminal functions, and Japanese character sets with 3000–7000 characters. The 16-bit microprocessors are generating a lot of excitement as well. The 8088 appears to be winning the 16-bit popularity contest. One of the earlier 8-bit systems already offers an 8088 plug-in card.

Traditional excellence in miniaturization is evident in the current crop of Japanese pocket and portable computers. Even though the Japanese have little outside competition, the domestic market is characterized by fierce scrambling.

A move toward office automation is keeping the domestic microcomputer market booming. Despite the initial high cost of dedicated word-processing systems (around $12,000), they quickly became essential office equipment. These word processors use one of several methods to enter and manipulate the Japanese language, which consists of two syllabaries, or kana, and thousands of individual characters. One entry method uses a board with several thousand characters printed on it. A stylus helps the user select the characters to enter. A more popular method uses a keyboard with the syllabaries. Using about 50 characters only, this method is easily implemented on a qwerty-style keyboard. The user simply types the symbols for the sound of a character and then presses a button. The machine decodes the input and produces a character. Most systems can even determine the character you want from the context in which it's being used. This capability is essential with a language in which many characters have the same sound. These word-processing systems are usually sold complete with dot-matrix printers (24 by 24 dots) that produce good-quality printouts. Hardware and software advances have brought the prices for these systems down to around $3000 and the low cost is a factor in the growing strength of the domestic market.

The Software Scene

While Japanese hardware distinguishes itself with special advanced features, several problems plague the software development effort.

With the two syllabaries and thousands of characters, the Japanese language is much more difficult than English to manipulate electronically. Few of the current microcomputers can easily be used for word processing, although some progress is evident. Another factor in the software industry's slow growth is that use of disk drives is not as widespread as it is in the U.S. This places a severe limitation on the type of software that can be marketed to a wide audience. Additionally, the use of computers in business applications lags far behind that in the United States. Electronic spreadsheets such as Visicalc are having an effect on the use of microcomputers in Japan, but this is a recent development.

Availability of software is another important issue. The number of domestic private software houses remains small and premium prices are charged for imported software—usually a 100 percent markup over the U.S. list price. However, the situation could

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men say that the Trigem 20 differs from the Apple II in the video color signals, ROM software, and power supply. According to Trigem, the government of Korea is distributing 5000 microcomputers to the country's high schools, 1000 of which will be Trigem 20s. The export price of the Trigem 20 is $350 in quantities of 3000, with a 9-inch green-phosphor video monitor selling for $68 in the same quantities.

The Korean electronics industry developed rapidly, and by 1981 consisted of almost 800 companies employing 270,000 people. Two-thirds of the $3.8 billion annual production is components, with another one-fifth devoted to consumer electronics. The Korea Institute of Electronics Technology and the Korea Electro-technology and Telecommunications Research Institute have concentrated on digesting and improving imported technologies. The Electronic Industries Association of Korea expects these research institutes to generate advanced technol-

change soon because most Japanese microcomputer manufacturers are concentrating their efforts on standard operating systems. This should encourage the development of software in Japan and also encourage the importation of American software with a corresponding increase in the exportation of Japanese hardware.

Both production and distribution of software are rapidly becoming part of the book publishing domain. Simple cassette programs appear alongside magazines and other printed materials in bookstores across Japan. Most of the stores provide microcomputers so potential software buyers can try programs before purchasing. As you might expect, this attracts a lot of attention and so far I have been unable to push past the children to try any programs myself.

Intense Interest

The Japanese express a great deal of interest in microcomputers and appear to be welcoming them into their lives. A current television series on microcomputer programming is aimed at beginners and more conventional instruction is offered in a variety of places from computer stores to private schools. These courses target every possible group of future computer users. Japanese computer magazines reflect the growing demand for computer information with their multiplying numbers and rapid increases in size.

Although the Japanese have not yet made a strong showing in American markets, they're fully aware of the potential for profit in the U.S. Japanese domestic products are well designed and competitively priced and their success with low-cost printers and video displays indicates their ability to play a strong role in the American personal computer market. While this competition may bring difficulties for manufacturers, the benefits for end users should be plentiful. ■

ogies for integrated circuits, computers, and telecommunications. One goal mentioned at the electronics show is to produce 64K-bit dynamic RAM chips in 1984 using home-grown technology.

Taipei, Taiwan

The Taiwan Electronics Show, held at the China External Trade Development Council Exhibition Complex in Taipei, had 511 exhibitors. While most products displayed were consumer electronics or components, I saw a lot of computer products too.

The most common microcomputers made in Taiwan are blatant copies of the Apple II. Also shown were an apparent copy of the Radio Shack TRS-80 Color Computer and two copies of the Osborne 1. An Osborne 1 copy called the Datatree Portable Business Computer had a 9-inch screen, two double-density floppy-disk drives, and all the software usually bundled with the Osborne 1; this machine cost $800. The second Osborne-like portable, made by GRE Rong Electronics, includes a 6502 processor, as well as a Z80, and claims compatibility with both the Apple II and the Osborne 1.

I didn't get to see, as promised, a third Osborne look-alike. Its designer refused to bring his prototype to the Taiwan Electronics Show and insisted on a private meeting with me miles away at the office of one of his friends. When the designer arrived, more than an hour late, his appearance presented quite a contrast to the usual conservatively dressed Taiwan businessman. Half-inch-long white stitches left me no doubt about how his purple suit was put together. His purple and orange floral print shirt and inch-wide white polkadots in his purple tie set up a high-frequency oscillation with the seams of the suit.

Under the circumstances, there was real danger of my overlooking the business of the meeting. But, I asked, "Where's your Osborne look-alike?"

His eyes shifted from place to place as if looking for assassins. "If anyone saw it," he said earnestly, "they might copy my design."

If it happened to Adam Osborne, it could happen to him.

Some businessmen on the island explain the epidemic of Apple II copies as a response to the Nationalist Chinese government's ban of video games. Many companies in Taiwan had bought great quantities of discrete logic circuits and 6502 microprocessors in preparation for an expected boom in the game-machine market. The government's ban left these companies with huge inventories of chips useful for building Apples. That might explain the Apple copies, but what about the bastard Osbornes?

Because U.S. Customs officials are watching for products from Taiwan that infringe upon American patents and copyrights, Americans would be ill-advised to rush off to Taipei to pick up a $245 Apple or an $800 Osborne clone. Furthermore, some local insiders told me during the show that many electronics firms in Taiwan are pushing the government there to ban the export of these illicit products. Many in Taiwan believe that copyright and patent infringements in electronics damage the reputation of the entire electronics industry in the Republic of China and injure the island nation's trade. Despite great economic advantages, some foreign companies are reluctant to manufacture in Taiwan for fear that designs will be copied by local entrepreneurs and sold on the open market at unbeatable prices.

Some respectable Taiwan firms that make legal Apple-compatible products are tired of having to defend themselves against charges inspired by illicit Apple-clones made by other firms. For instance, Stan Shih's Multitech Industrial Corporation produces the successful and lawful 6502-based Micro-Professor II, and Shih is incensed when people call that compact machine a copy of the Apple. The Micro-Professor II packs 64K bytes of RAM and a 16K-byte ROM BASIC into a unit slightly larger than an average modem. The computer will execute most Apple II software because its own software uses system calls compatible with those in the Apple's operating system. Priced in Taiwan at around $200, the Micro-Professor II is not an imitation of an Apple but an improvement on it. The Micro-Professor II accepts software cartridges as well as audio-cassette-based software (the audio recorder and a disk-drive controller are optional). According to Shih, the Multitech BASIC interpreter has 90 instructions more than Applesoft BASIC.

Micro-Professor II has enjoyed great success in Taiwan (see the thronged



Multitech show booth in photo 5) not only because of its compactness and low price, but also because of its optional Chinese character controller (CCC). The Z80-based CCC adds another 64K bytes of ROM and 2K bytes of RAM to the little Micro-Professor II, and gives the user access to 22,000 Chinese characters, each displayed in a 16 by 16 matrix. With the CCC installed, the Micro-Professor permits the user to enter BASIC programs in either Chinese or English. Multitech recently remedied the only obvious deficiency of Micro-Professor II—its small keyboard—by offering a full-size typewriter keyboard as an inexpensive option. The optional keyboard has cursor keys and two "fire" keys, the latter for games. At least one member of the Far East Electronics Tour left Taiwan with a Micro-Professor II in his luggage.

Multitech now has more than 250 employees and annual revenues of $20 million. The company's future products will include a portable computer.

Tony Jwang of J. E. Computer Company says that the only way for Taiwan's microcomputer companies to survive is to stop copying foreign machines and design their own. However, J. E. Computer now produces computers compatible with the Radio Shack TRS-80 Color Computer and the Apple II.

Taiwan's answer to Japan's MITI is ERSO, the Electronics Research and Service Organization of the Taiwan Industrial Technological Research Institute. Since 1974, ERSO has been transferring electronics technologies to local industry. ERSO develops electronic products more advanced than those of local industry and then assigns the manufacturing rights to a private Taiwan company. Recent ERSO products include the EMB86/01, an 8086-based single-board computer for the Multibus. ERSO also developed the BC-1000, a multiuser Z80A-based computer running the MP/M multiuser operating system, and turned manufacturing and marketing over to PECOR (President Enterprises Corporation), a private company in Taipei. ERSO's highest priorities now include development by 1984 of VLSI (very large-scale integra-

tion) technology capable of producing 64K-bit RAMs and development of microcomputers and minicomputers. One of ERSO's goals is to foster the computerization of Taiwan.

Hong Kong

The Hong Kong Consumer Electronics Show revealed several microcomputers made locally. Video Technology makes two home computers. The Creativision uses a 6502A microprocessor running at 2 MHz and has 16K bytes of user RAM and a 12K-byte BASIC in ROM. The system serves as a game machine as well as a computer. The compact VZ100 Personal Computer has a Z80A running at 3.58 MHz, up to 35K bytes of RAM, 8K bytes of ROM containing system software and a BASIC interpreter, and a 45-key rubber keyboard.

Eaca International Ltd. has been making microcomputers in Hong Kong since 1979. The product line includes four different Z80-based microcomputers, the Genies I through IV. The Genie III is an all-in-one desktop computer that has a 4-MHz Z80A, 64K bytes of RAM, two 5¼-inch floppy-disk drives, and runs CP/M version 2.2. Two exhibitors in the Hong Kong Consumer Electronics Show said that the Crown Colony has set a goal of becoming a net exporter of computers by 1985.

Beijing, China

For the 20 members of the American Electronics Association trade mission to Beijing, the Chinese capital held several surprises. The first was the Chinese-language NEC PC-8001B used behind the desk at the Yanjing Hotel. The second was the amount of attention devoted to the trade mission by officials of the Fourth Ministry of Machine Building of the People's Republic of China, also known as the Ministry of the Electronics Industry. Three representatives, Huang Zhao Ming (seen in the dark gray coat at center in photo 6), president of the China Electronics Import and Export Corporation (CEIEC), and Li De Guang and Sun Shunxing, respectively vice-president of the corporation and director of the corporation's Department of Trade Relations, met with members of the trade mission for several hours.

While some discussions centered on the particular trading interests of the members of the trade mission, the Chinese emphasized their desire for the relaxation of export restrictions on American technology. At dinner one night at Beijing's International Club, the tour members joined the Chinese officials in repeated moutai toasts to the easing of restrictions on LSI and VLSI technology. (Moutai looks like vodka and tastes like death.) To date, the United States government has turned down export licenses for all integrated-circuit technology more complex than that of 2K-bit RAMs.

According to Peter Handley, a commercial officer in the United States Embassy in Beijing, CEIEC has in recent years imported about $160 million in electronic equipment annually, including computers from Hewlett-Packard, DEC, IBM, Apple, Intel, and Cromemco. Photo 7 shows the crowded Osborne Computer booth at China Comm 1982, an exhibition of Western communications and computer equipment. The Stalin-Gothic-architecture Beijing Exhibition Center was packed with Chinese visitors; the only free space was inside the booths, as shown in Hewlett-Packard's large and popular booth (see photo 8). Other exhibitors included California Computer Products, Burroughs, Cromemco, Honeywell, IBM, Perkin-Elmer, Prime, and Wang.

Handley briefed the trade mission on the current state of electronics in China: "The Chinese electronics industry is still working in the late 1960s or early 1970s. They have a few research institutes that can produce a few advanced semiconductors. They make a few microprocessors."



Photo 6: *The American Electronics Association trade mission met with representatives of the People's Republic of China Electronics Import and Export Corporation (CEIEC), including its president, Huang Zhao Ming (in dark gray coat at center).*

CEIEC prefers importing entire production lines rather than products. France recently sold China a complete plant for making minicomputers, magnetic disks, and printers. Four Japanese firms have sold China complete production lines for electronic components. West Germany and the United Kingdom have made similar deals. In the past two years, the United States has sold China only one electronics factory, valued at $8 million.

Handley says that China's main goals for electronics imports are field-effect transistors, acoustic wave filters, integrated circuits and LSI manufacturing equipment, magnetic recording heads, and satellite earth stations. China wants to buy 15 satellites and the technology required for manufacturing its own.

The CEIEC arranged a tour for our group of the Beijing Wire Communications Factory, which makes telephone exchanges and 32-bit and 48-bit minicomputers. Photo 9 shows the front panel of one of these minicomputers. The 32-bit machine comes with 64K bytes of RAM; the 48-bit machine has 32K bytes of RAM expandable to 128K bytes and runs FOR-



Photo 7: *Osborne Computer Corporation's booth at China Comm 1982 was crowded with computer enthusiasts.*



Photo 8: *It was standing room only at China Comm 1982. The only free space was inside the booths, such as Hewlett-Packard's, shown here.*

TRAN, ALGOL, and BASIC. The factory has been working in cooperation with Honeywell for about a year and several of its staff members are currently living in Minnesota for training.

Many members of the tour were surprised by the level of poverty in the Chinese capital. Since no one has refrigeration, in late fall the Chinese pile bok choi (Chinese cabbage) high in vacant lots and on roofs and balconies in the hope that nature will preserve it as the only green vegetable for the winter months. Everywhere men and women are engaged in brute, physical labor, and the sight of a woman pulling a cart full of rocks or bricks is all too common.

China is seeking to quadruple its annual industrial and agricultural output by the year 2000. During the trade mission's visit, the English-language *Beijing Review* quoted Premier Zhao Ziyang as saying that meeting the country's production goals depends on progress in science and technology. To quote that publication:

> *Addressing a national science and technology awards conference held in late October, Premier Zhao specified a guiding principle for China's economic construction: develop science and technology in order to boost the national economy. He said that every department engaged in national economy must stress achieving technical progress so as to gradually shift production to a new technological basis.*

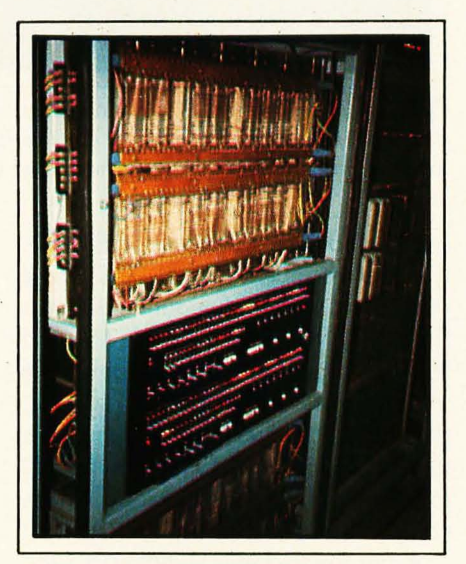


Photo 9: *Front panel of a 32-bit minicomputer made at the Beijing Wire Communications Factory.*

Zhao went on to say that building new factories would not be enough; old factories must be technically transformed as well. In the same issue of the *Beijing Review* (November 1, 1982, volume 25, number 44), Hi Qiamou, honorary president of the Chinese Academy of Social Sciences, was reported to have endorsed the maxim "Let a hundred flowers blossom and a hundred schools of thought contend" in scientific and cultural work.

During the trade mission's days in Beijing, the Chinese made no effort to hide the backwardness of their industry; instead, they appealed for help. Most members of the trade mission felt sympathy and expressed hope for wider trade, but a few raised concerns about possible military uses of microprocessor technology if the Chinese leaders once again come to regard the United States as an arch-enemy.

The impression of centralized power is so forceful in Beijing that I believe no action by the Chinese government can be ruled out. The Chinese tour guide denounced the emperors for denying the common people even the right to use colors other than gray and dark blue, reserving brighter colors for the nobility and yellow for the emperor alone. But almost all the people of Beijing still wear gray or dark blue. When the guide pointed out the building from which the premier now governs the People's Republic, Americans noticed that the roof is the same yellow as the tiles on the roof of the Imperial Palace. Americans can hardly predict the ultimate uses of microprocessors in a land that still thinks in such terms.■

For background information on the Japanese microcomputer industry see "The Japanese Computer Invasion" by Stan Miastkowski, August 1981 BYTE, page 200. The May 1982 issue of BYTE also contains several articles on Japanese microcomputers, the state of the industry, and the manufacturers themselves.

Taxan monitors when precision counts

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The desire to have letter-quality printing for the output of programs such as word processors is common among computer hobbyists. Purchasing a letter-quality printer, such as a Diablo terminal, is usually out of the question because of the high cost—$1500 to $3000. One option is to buy a used IBM Selectric typewriter and install a commercially available computer interface. This process does have drawbacks, however. It ends up costing more than $1000 and can require major modifications to the typewriter.

Another option is the solenoid-activated key-pusher, a unit that fits over a standard typewriter keyboard and emulates a human typist. This method has two major drawbacks. First, because the key-pusher is mechanical, it tends to decay with time; second, the quality of the text is limited to the quality of the typewriter itself.

These two forms of typewriter conversion share the same goal: translating a computer's digital-control signals into the mechanical actions necessary for printing. With the recent introduction of the low-cost Olivetti electronic typewriter (see photo 1), the manufacturer has tackled this problem for you. The question now becomes: How can the hobbyist interface a home computer to the electronics? This article describes a low-cost interface between a typical hobbyist computer or small business computer and the Olivetti Praxis 30 electronic typewriter.

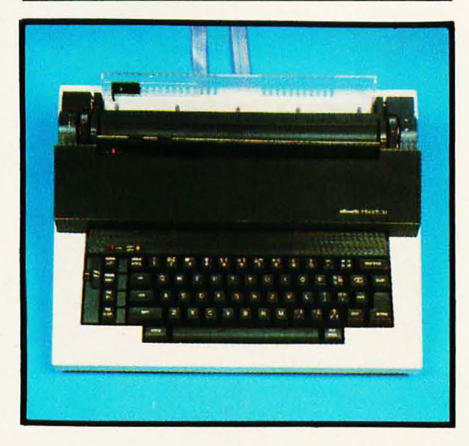


Photo 1: *The Olivetti Praxis 30 electronic typewriter. The two cables in the rear connect to a parallel port on a microcomputer.*

The Typewriter

The Olivetti Praxis 30 is a portable electronic typewriter with high-quality print. Its retail price is about $250. Like the popular Diablo terminal, it uses a carbon ribbon cartridge ($4 each) for crisp type and has interchangeable print wheels ($30 each) for variations in style. The Praxis typewriter is controlled internally by two mask-programmed Fairchild F8 microprocessors. All functions—such as tab stops, margins, carriage movements, printing, and keyboard scanning—are controlled by these two chips, with some help from SSI (small-scale integration) interface chips. This electronic control makes the Praxis typewriter ideal for interfacing to a computer.

Interfacing the Praxis Typewriter

It is possible to interface the Praxis typewriter to a typical home computer in two obvious ways. The first method requires that the F8 microprocessors be removed and their functions emulated by your computer. These functions include control of the carriage stepper motor, print-wheel motor, type motor, and other motors and sensors. This approach offers the most versatility in determining interletter spacing and print speed. (The interletter resolution determines the output quality of most word processors.) I tried this way first and failed miserably. While controlling the carriage stepper motor is relatively easy, controlling the print wheel is not because the print-wheel motor is a standard DC motor, not a stepper.

After many hours of observation using a logic analyzer, I determined that the Praxis typewriter microprocessors position a character for typing by carefully pulsing the print-wheel motor in one direction, causing the character to pass beyond the print hammer, and then reversing the motor with timed pulses until the character is properly aligned under the hammer. This timing varies with the character positions on the print wheel, and I was unable to determine the algorithm. Because Olivetti considers this timing information proprietary, calling its engineering department led to a dead end.

I chose the second and easier interface option: working with the micro-

About the Author

Stuart Brown received a B.S. degree in electrical engineering technology from Purdue with a minor in computer science. He has worked for five years at Bell Labs in the Interactive Digital Systems Research department. He is currently attending Rutgers for an M.S. in electrical engineering.

		I0	I1	I2	I3	I4	I5	I6	I7
		B33	B32	B31	B30	B29	B28	B27	B26
O0	A8		1	2	3	4	6	5	Tab
O1	A9	Reloc	'	;	l	k	j	h	Marg Bypass
O2	A10	Corr	?	.	,	m	n	b	Half Space
O3	A11		q	w	e	r	t	7	Marg Left
O4	A12		a	s	d	f	y		Marg Right
O5	A13	Shift Lock	½	p	o	i	u	Back-space	Tab Set
O6	A14	Repeat	=	–	0	9	8	Return	Expr
O7	A15		z	x	c	v	g	Space	Tab Clear

Table 1: *The columns of this scan matrix are the bits (and corresponding pins) that are individually pulled low by Processor B for keyboard scanning. The rows are the bits (and pins) that are sensed by Processor A. Blanks in the matrix are either unassigned or unidentified scan positions.*

processors rather than without them. This involves emulating the keyboard action, that is, making the microprocessors think that someone is typing.

I first observed how the keyboard is scanned. One of the typewriter's two F8 microprocessors, which I call Processor B, is responsible for asserting, by pulling low, one of eight scan lines that form the columns of a key matrix. The other F8 (Processor A) senses which line connected to the key rows goes low when a key is closed. This key is then identified by the F8 software through its position in the matrix. Using an ohmmeter, I traced the keys to identify their positions in the 8 by 8 scan matrix (see table 1). The *shift* function is not part of the scan matrix; it is a special input to Processor A.

To print a character (or perform a nonprinting function such as a margin set) with the cooperation of the typewriter's microprocessors, you sense the row scan lines until the appropriate one-of-eight code is transmitted by Processor B. You then emulate a key closure by pulling low the Processor A line corresponding to the desired key's matrix row position. For example, to type the letter "s," wait for pin 31 of Processor B (bit 2) to go low. For as long as it is low, bring pin 12 of Processor A (bit 4) low. As mentioned, the shift function has a dedicated input line of its own. To shift to uppercase, pin 17 on Processor A is held low during the sense/assert operation for the character to be shifted.

The keyboard is software debounced by the Praxis typewriter's microprocessors, which means that a key must remain closed during four scans to be recognized as a valid entry. In the controlling program, the action of sensing and pulling low is repeated four times.

The advantage of this sense/assert interface is that the typewriter keyboard can still be used for normal typing without disconnecting anything. The resolution of your word-processing program is limited by the resolution of the typewriter (one-half space). The only required modification to the typewriter is to solder 19 wires to the pins of the two microprocessors.

Hardware Configuration

To interface the Praxis typewriter to your computer, you need nine output, or assert, lines (eight as part of the scan and one for the shift function); eight input, or sense, lines; and a couple of grounds. These usually come from a parallel-port board or chip. A good choice is the Intel 8255 parallel-interface chip, which has 24 I/O (input/output) lines. Ideally, your port's output lines should go through an open collector buffer to allow the keyboard to bring Processor A's inputs low when a key is

pressed. However, the 8255's totem-pole outputs don't seem to mind the brief short circuit to ground. I built a minimum-configuration, 4-MHz Z80 system whose sole purpose is to run the typewriter. It sits in-line between the host computer or modem and my terminal. You will probably want to use your microcomputer to do the job and save money.

The first step in connecting your port to the Praxis typewriter's processors is to disassemble the typewriter and remove the computer control board. The step-by-step procedure is as follows:

1. Turn off and unplug the typewriter. With it facing you, lift the hinged cover that protects the print mechanism. It hinges on a rod that runs horizontally through the platen. Gently pull the right end of the cover until the plastic hinge clears the rod. Then slide the left side of the cover off the rod.
2. Twist off the plastic platen handgrips by rotating each one counterclockwise. Also, it is a good idea to remove the ribbon cartridge.
3. Turn the typewriter over and remove the four screws that hold the plastic base on—two at the front edge and two at the rear.
4. Right the typewriter and lift off the plastic case. The keyboard remains mounted to the base.
5. Remove the two screws that hold the keyboard assembly to the base and lift the keyboard up slightly. Five cables must be unplugged from sockets on the rear of the keyboard assembly. Remember their orientation. Photo 2 shows the keyboard assembly with the Praxis typewriter cables removed. The two cables at the bottom are from the parallel port.
6. The keyboard can now be removed from the base. Turning it upside down, you discover that the circuit card is held to the keyboard card by three nuts. Remove these nuts and save the two grounding flanges (remembering the orientation of the flanges).
7. The processor card can now be separated from the keyboard card with the flexible ribbon cable acting as a hinge. Orient the boards as shown in photo 3. Note the locations of Processors A and B and the new cable wiring.

I suggest using a ribbon cable to attach your parallel port to the circuit card. Figure 1 is an interconnection diagram between an Intel 8255 port chip and the Praxis typewriter microprocessors. Solder the cable wires to the pins of Processors A and B on the foil side of the printed-circuit card. Use the same caution you would to solder a microprocessor into a board. [**Editor's Note:** *Unless you have had some kit-building or soldering experience, you should* not *attempt to solder wires to a printed-circuit board.*] Plug the other end of the cables into your parallel port and use an ohmmeter to check for proper wiring. The cables can be brought out of the typewriter by cutting slots in the ventilation holes in the case under the

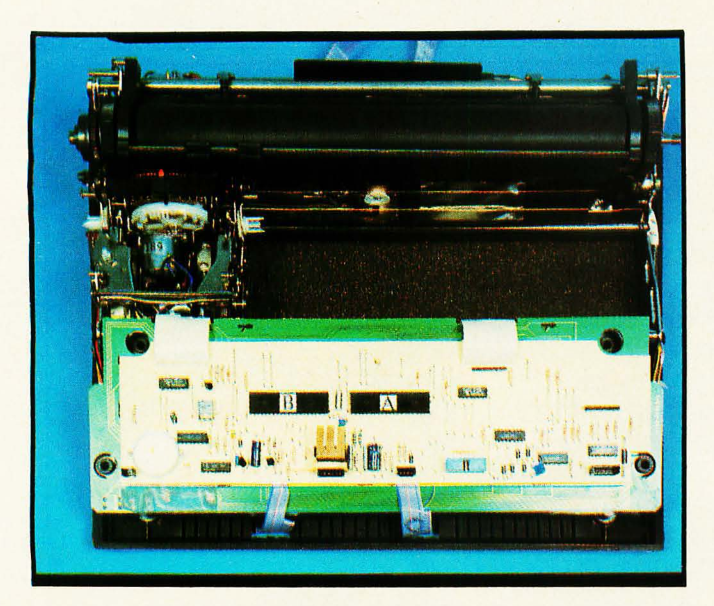


Photo 2: *Bottom view of the component side of the keyboard assembly. Processors A and B are identified.*

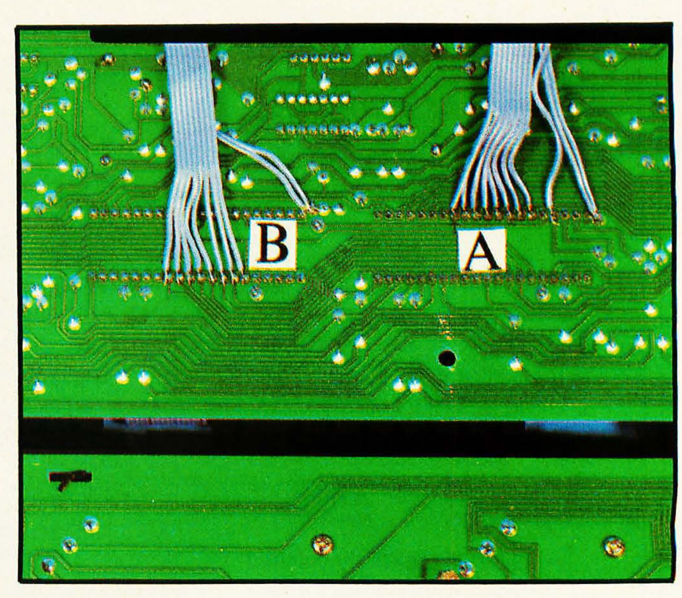


Photo 3: *View of the printed-circuit side of the Praxis processor board. Note where the flat ribbon cables are connected to the A and B processors. Wires from Processor A connect to the output side of the parallel port. The lower board is the keyboard.*

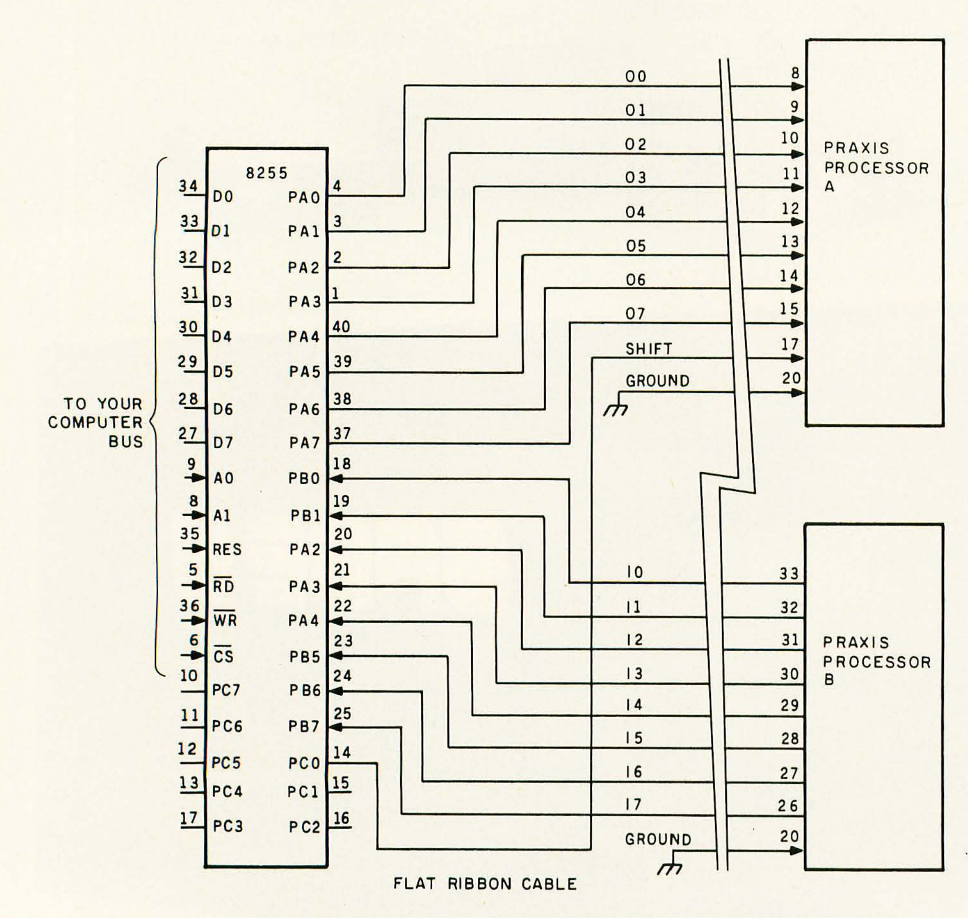


Figure 1: *The interconnection between an Intel 8255 parallel-port chip and the Praxis microprocessors.*

keyboard. Reassemble the keyboard and typewriter by reversing the disassembly steps.

Software

The interface program (see listings 1 and 2 on pages 254-261) fits in less than 1K bytes, plus however much RAM you wish to allocate for buffer space. I assume a 2K-byte buffer in my code. The software is written in the C language and Z80 assembly code. C can be easily translated into assembly code or BASIC. The assembler I use has nonstandard (but Zilog-like) mnemonics. Assembly language is necessary for the interrupt handling and the critical timing of the keyboard sense/assert loops. I use interrupts because characters arrive from a host computer on a serial line to my special-purpose Z80 system, but other hardware/software combinations might not require interrupts.

Figure 2 is a flowchart of the control program. The typewriter is inherently a very slow device. Some speed is gained by taking advantage of the 12-character buffer that the typewriter's microprocessors use, but there is a danger of overflowing this buffer if the delay constants in the C program are changed. These con-

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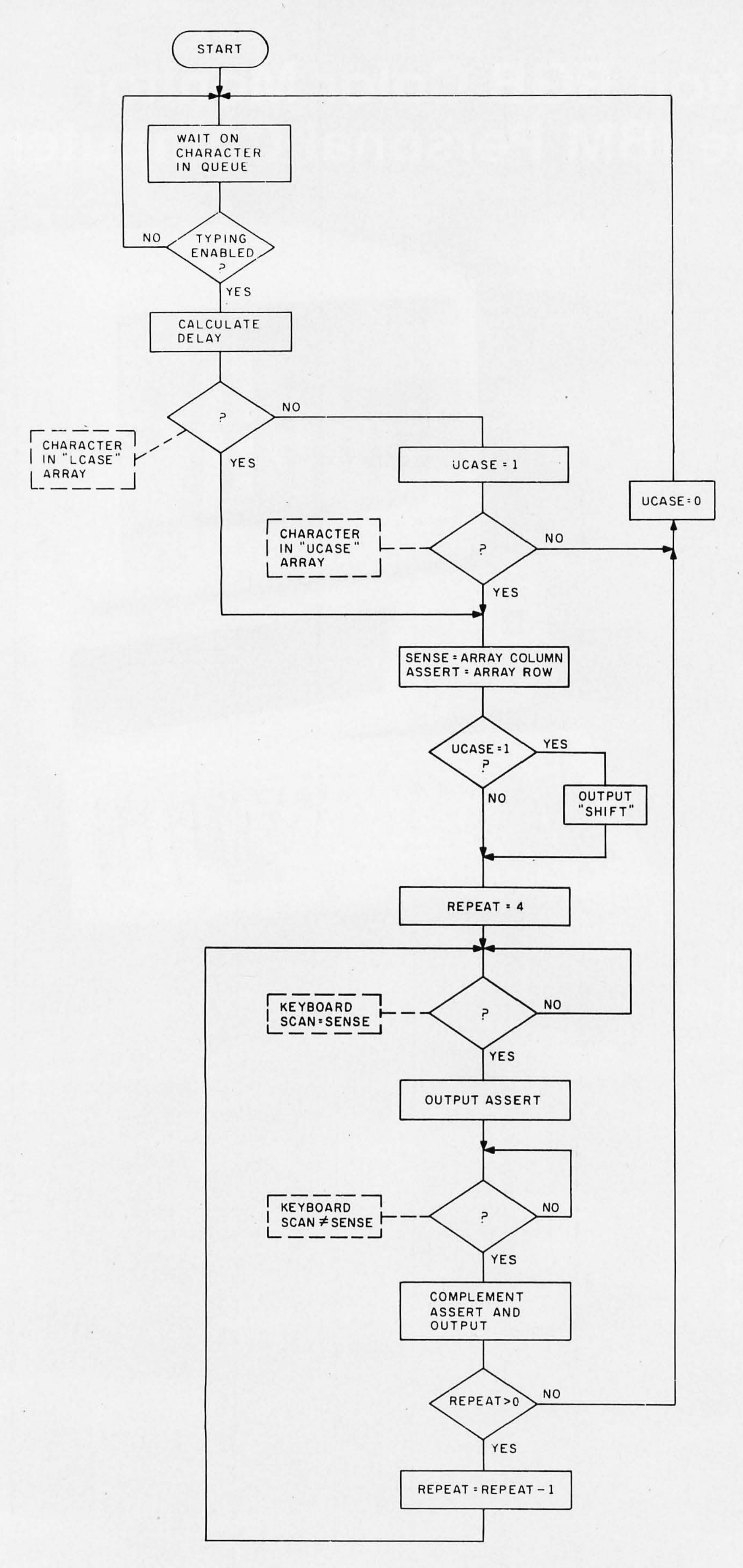


Figure 2: *A flowchart of the controlling software as implemented in the C and Z80 assembler programs.*

stants assume a 4-MHz processor clock.

The assembly-language routines and their functions are detailed below. Names preceded by an underscore are symbols external to the C program.

int—Called on an interrupt that occurs when a character is received in the serial port. The character is queued by int, which also transmits a Control-S to the host computer when the character queue is in danger of overflowing.

start—The parallel and serial ports are configured here. All variables are cleared and the queue pointers are set to their initial values. The stack pointer is set and interrupts are enabled. Finally, the C program is entered at its beginning (*_main*).

lputc—A character passed by _getc is output on the serial line to the host.

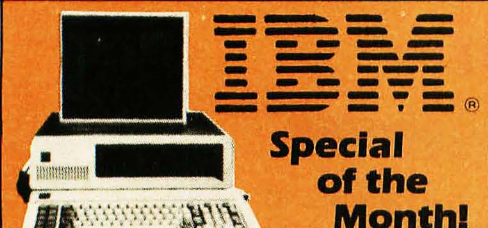
_getc—This routine is called from C to check and return characters from the queue. If no character is available, a −1 is returned; otherwise, a character from the queue is returned and the queue pointers are updated. If this causes the queue to empty, a Control-Q is sent to the host and the pointers are set to the base of the queue.

_put—This routine is called with two arguments. The first is the value that Processor B will be asserting (and we will be sensing) when the desired key is being scanned. The second argument is the value we assert on Processor A's pins. The shift line is pulled low if the C program has set the variable *_upper* to 1.

The delay loops in the C program assure that the characters are not sent to the typewriter faster than it can type or buffer them. If you have hardware timers available, the size of the program can be reduced. I have designated two Escape sequences to control typing. Until the TYPE_ON code (ESC followed by Control-B) is received, characters are returned from the queue by _getc but are ignored in the C loop. To type a character, a delay is first calculated. This delay allows time for the typewriter mechanics to print the character and/or move the carriage. Special

Text continued on page 262

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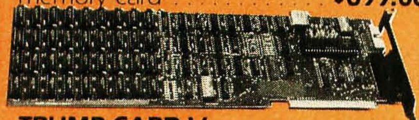
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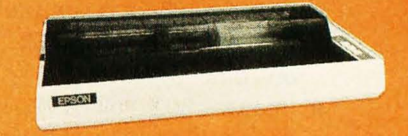
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Listing 1: *The C program.*

```
/•
 • Global variables
 •/
char    upper;                   /• upper case flag - used in "put" routine •/
unsigned int   delay1, delay2;              /• typing delays •/

/•
 • After assembly code initialization, the program
 •    is entered here.
 •/
main()
        |
        char    a;
        char    ccount;          /• holds the current print position •/
        char    type;            /• if "type" = 1, typing is enabled •/

        type = 0;                /• default values •/
        upper = 0;
        delay1 = 0;
        ccount = 0;

        while(1)                 /• infinite loop •/
                |
                /•
                 • "getc" is the assembly language routine
                 •     that checks for a character in the queue.
                 • If the queue is empty, "getc" returns a EOF.
                 • Otherwise, the character is returned.
                 •/
                if((a = getc()) == EOF) continue;

                /•
                 • If the char begins an escape sequence
                 •  get another char to see which.
                 • Otherwise, if type = 0, continue waiting.
                 •/
                if(a == ESC)
                        |
                        while((a = getc()) == EOF);  /• need another char •/
                        if(a == TYPEON)
                                type = 1;            /• enable typing •/
                        if(a == TYPEOFF)
                                type = 0;            /• disable typing •/
                        continue;
                        |

                /• continue looping if typing is disabled •/
                if(!type) continue;

                /•
                 • Type a character. First check for special
                 •    characters that will need long delays.
                 •/
                switch(a)
                        |
                        case NL:
                                /•
                                 • A line feed can only be done
                                 •    in conjunction with a carriage
                                 •    return. Go back to the main
                                 •    loop.
                                 •/
                                continue;

                        case CR:
                                /•
                                 • Calculate carriage return delay.
                                 • "ccount" holds the current print position.
                                 • The minimum delay is for a line feed alone.
                                 • "delay1" is set to CRDEL • ccount.
                                 • If CRDEL • ccount > 65536, delay2 is
                                 •     set to count the overflow.
                                 •/
                                if(ccount == 0)
                                        |
                                        delay1 = LFDEL;       /• minimum delay •/
                                        break;
                                        |

                                if(ccount > MAXCDEL)
                                        |
                                        /•
                                         • Set delay1 to maximum.
                                         • Set delay2 to the overflow.
                                         •/
                                        delay1 = MAX16;
                                        delay2 = CRDEL • (ccount - MAXCDEL);
                                        |
                                else delay1 = (CRDEL • ccount) + LFDEL;
                                ccount = 0;    /• reset this to position 0 •/
                                break;


/•
 • These are the various delay constants
 •    (in decimal) used by the C program to
 •    make sure that the buffer internal to
 •    the Praxis will not overflow.
 •/
#defineBSDLY   6000              /• delay after back space •/
#defineLFDEL   11000             /• delay after line feed •/
#defineCRDEL   1000              /• carriage return delay per character •/
#defineMAX16   65535             /• maximum value in a register pair •/
#defineMAXCDEL 54                /• MAXCDEL = (MAX16-LFDEL)/CRDEL •/
#defineCDEL    3000              /• delay after each char •/
#defineTABDEL  900               /• delay for tab space •/
#defineTABSIZ  8                 /• nominal tab size in spaces •/
```

Listing 1 continued on page 256

Listing 1 continued:

```
/*
 * Control functions
 * These codes correspond to non-printing functions,
 *    as found in the arrays "lcase" and "ucase"
 */
#define EMPTY   0x00   /* for empty matrix positions */
#define RELOC   0x03   /* reloc key */
#define MARB    0x04   /* margin bypass */
#define CORR    0x05   /* correcting key - never used */
#define HALF    0x06   /* half space */
#define MARL    0x07   /* set left margin */
#define BS      0x08   /* back space */
#define TAB     0x09   /* tab to next stop */
#define NL      0x0a   /* line feed - only available with carriage return */
#define MARR    0x0b   /* set right margin */
#define LOCK    0x0c   /* shift lock */
#define CR      0x0d   /* carriage return with line feed */
#define OH      0x0e   /* 1/2 (not an ASCII character) */
#define TABC    0x0f   /* clear tab stop */
#define TABS    0x10   /* set tab stop */
#define EXPR    0x11   /* carriage return without line feed */
#define REP     0x12   /* repeat */
#define SP      0x20   /* space character */

#define ESC     0x1b   /* ASCII "escape" */


/*
 * No typing will be done until the sequence
 *    ESC TYPEON is received. All characters received
 *    after ESC TYPEOFF will be ignored
 */
#define TYPEOFF 0x01
#define TYPEON  0x02
#define EOF     -1
/*
 * These are arrays.
 *
 * "bit" converts binary to one-of-eight code
 */
char    bit[8] = {0x01, 0x02, 0x04, 0x08, 0x10, 0x20, 0x40, 0x80};

/*
 * Lower Case characters and codes.
 *
 * The indexes into this array determine
 *    that key's position in the keyboard matrix.
 * Note that the first index corresponds to the
 *   column and the second index to the row.
 *
 * The ' character is escaped with a  */
char    lcase[8][8] =
        {
        EMPTY, '1', '2', '3', '4', '6',    '5',   TAB,
        RELOC, ' ', ';', 'l', 'k', 'j',    'h',  MARB,
         CORR, '/', '.', ',', 'm', 'n',    'b',  HALF,
        EMPTY, 'q', 'w', 'e', 'r', 't',    '7',  MARL,
        EMPTY, 'a', 's', 'd', 'f', 'y',  EMPTY,  MARR,
         LOCK,  OH, 'p', 'o', 'i', 'u',     BS,  TABS,
          REP, '=', '-', '0', '9', '8',     CR,  EXPR,
        EMPTY, 'z', 'x', 'c', 'v', 'g',     SP,  TABC
        };


/*
 * Upper Case - corresponds to chars on keys in lcase[]
 *
 * If a character cannot be found in "lcase", this array is
 *    searched. "ucase" = 1 for the "put" subroutine if the
 *    character is found in this array.
 */
char    ucase[8][8] =
        {
        EMPTY, '!', '@', '#', '$', EMPTY,    '%',   TAB,
        RELOC, '"', ':', 'L', 'K',   'J',    'H',  MARB,
         CORR, '?', '.', ',', 'M',   'N',    'B',  HALF,
        EMPTY, 'Q', 'W', 'E', 'R',   'T',    '&',  MARL,
        EMPTY, 'A', 'S', 'D', 'F',   'Y',  EMPTY,  MARR,
         LOCK,  OH, 'P', 'O', 'I',   'U',     BS,  TABS,
          REP, '+', ' ', ')', '(',   '*',     CR,  EXPR,
        EMPTY, 'Z', 'X', 'C', 'V',   'G',     SP,  TABC
        };


                    case TAB:
                            delay1 = TABDEL * TABSIZ;
                            ccount += TABSIZ;      /* character count */
                            break;

                    case BS:
                            delay1 = BSDLY;
                            break;

                    default:
                            delay1 = CDEL; /* any other character */
                            ccount++;
                    }

                /*
                 * Call the "lookup" subroutine to check
                 *    look for the character in array "lcase".
                 * If not there, check array "ucase".
                 *
                 * Characters not found are ignored.
                 */
                if(lookup(a, lcase) == 0)
                    {
                    upper = 1;
                    lookup(a, ucase);
                    upper = 0;
                    }
                }
        }
```

Listing 1 continued on page 258



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Listing 1 continued:

```
/*
 * This subroutine checks in "array" for the
 *    character in "v". If not found, a 0
 *    is returned. Otherwise, the character's
 *    row and column positions are converted
 *    to one-of-eight codes by array "bit" and
 *    passed to the assembly language routine "put".
 * Upon return from "put", delay1 and, if set,
 *    delay2 are counted down to zero.
 */
lookup(v, array)
char    v;
register char array[8][8];
        {
        char    x, y;

        for(v = 0; y < 8; y++)
                {
                for(x = 0; x < 8; x++)
                        {
                        /*
                         * x is the assert row, y the sense column
                         */
                        if(v == array[x][y])
                                {
                                put(bit[y], bit[x]);
                                while(delay1 > 0) --delay1;
                                while(delay2 > 0) --delay2;
                                return(1); /* character is in "array" */
                                }
                        }
                }
        return(0);      /* character was not in "array" */
        }
```

Listing 2: *The Z80 assembler program.*

```
                        /
                        / These are the assembly language routines
                        / The mnemonics are similar to Zilog's.
                        / Check the Z80 Assembly Language
                        / Programming Manual and you will see the
                        / similarities.
                        /
                        / Some examples:
                        /         Here                    Zilog
                        /       lda.nn 0x1234          LD      A,[1234H]
                        /       ldddnn hl,0xa12a       LD      HL,A12AH
                        /       ldr.ixda,8.            LD      A,[IX+8]
                        /       pushqq de              PUSH    DE
                        /       ld.nnddabc,de          LD      [abc],DE
                        /
                        / Numbers in the form 0x1234 are hex
                        /
                        /

0800               RAM    =     0x0800       / start of ram in my system
079c               BUFSIZ =     1948.        / buffer size, in characters
0014               HIGHW  =     20.          / high water mark. 20 from top of memory
1000               STACK  =     RAM+2048.    / stack pointer set here

00ff               INIT   =     0xff         / initial value in output port

                        / Intel 8255 parallel port
0000               PBASE  =     0x00         / port base address
0000               PA     =     PBASE        / Port A address
0001               PB     =     PBASE+1      / Port B address
0002               PC     =     PBASE+2      / Port C address
0003               CONT   =     PBASE+3      / Configuration command register
                        / Configuration command
008a               CONF   =     0x8a         / PA out; PB in; PC0-3 out; PC4-7 in

                        / Intel 8251 Serial Port
0004               TBASE  =     0x04         / port base address
0005               TSTAT  =     TBASE+1      / status register
0004               TDATA  =     TBASE        / data register
                        / configuration mode and command
004e               TMODE  =     0x4e         / 8 bit length; no parity; 1 stop bit;
0037               TCOMM  =     0x37         / enable rx and tx

                        / 8251 Status masks
0002               URBF   =     0x02   / receiver buffer full
0001               UTBE   =     0x01   / transmitter buffer empty

00fe               SHIFT  =     0xfe   / assert shift line (bit 0)
0011               GO     =     0x11   / CONTROL Q
0013               STOP   =     0x13   / CONTROL S

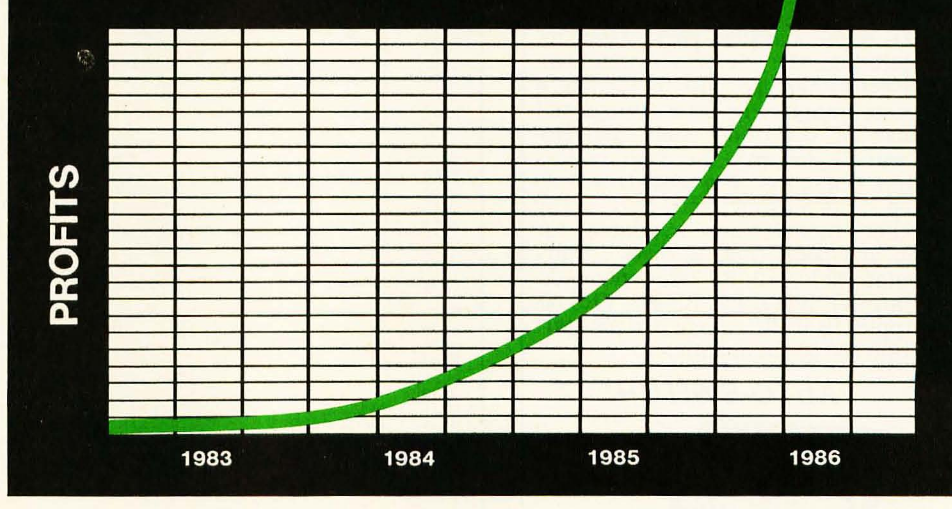
                        .globl  _main
                        .globl  _put,  _upper,  getc

0000    c3 82 00        jpnn    start

0038               .=.+0x35
                        /
                        / 0x38: IM1 vector - here on receiver buffer
                       / full interrupt
                        /
                        / Test the queue pointer fillp for its proximity
                        /   to the top of the queue (highw).
                        /
                        / If fillp <= highw, store char in buffer and
                        /       increment fillp.
                        / If highw < fillp < topmem, send STOP,
                        /       store char, and increment fillp.
                        / if fillp = topmem, send STOP, store char,
                        /       but do not increment fillp.
```

Listing 2 continued on page 260

Keep your bottom line on the up and up and up.



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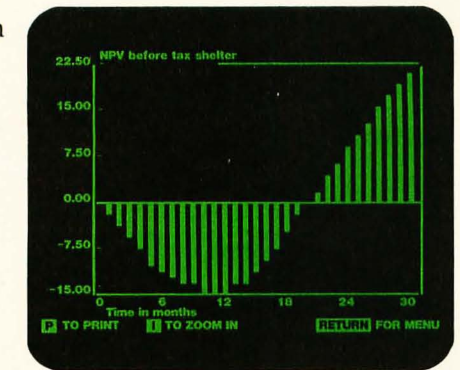
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The Bottom Line Strategist™

ASHTON·TATE

Circle 49 on inquiry card.

Listing 2 continued:

```
0038                int:
0038    f5                      pushqq af       / save af register
0039    d9                      exx             / save de, bc, hl registers

003a    3e 00                   ldrn   a,0
003c    32 00 08                ld.nna nomore           / clear flags
003f    32 01 08                ld.nna stopf
                                / first check proximity of fillp to highw
0042    21 8e 0f                lddd nn hl,highw
0045    ed 5b 02 08             lddd.nnde,fillp
                                / if fillp <= highw, store character normally
0049    af                      xorr   a                / clear carry
004a    ed 52                   sbchlssde               / highw-fillp
004c    30 17                   jrnce  int1             / c clear if fillp <= highw

                                / fillp is > highw. Send STOP and set stopf = 1
004e    3e 13                   ldrn   a,STOP
0050    cd b4 00                callnn lputc            / send STOP
0053    3e 01                   ldrn   a,1
0055    32 01 08                ld.nna stopf
                                / If fillp = topmem,
                                /   set 'nomore' so fillp won't be incremented.
0058    21 a2 0f                lddddnn hl,topmem
005b    af                      xorr   a                / clear carry
005c    ed 52                   sbchlssde               / topmem-fillp
005e    20 05                   jrnze  int1             / z clear if topmem != fillp
0060    3e 01                   ldrn   a,1
0062    32 00 08                ld.nna nomore           / set flag

                                / put char in buffer at fillp and increment fillp
                                /   if nomore = 0
0065                int1:
0065    2a 02 08                ldhl.nnfillp
0068    db 04                   ina.n  TDATA   / get character
006a    e6 7f                   andn   0x7f    / 7 bit ascii
006c    77                      ld.hlr a       / into buffer
006d    3a 00 08                lda.nn nomore
0070    fe 01                   cpn    1       / is nomore set?
0072    20 05                   jrnze  int2    / z clear if nomore = 0

0074    f1                      popqq  af      / restore register af
0075    d9                      exx            / restore bc, de, and hl
0076    fb                      ei             / re-enable interrupts
0077    ed 4d                   reti

0079                int2:
0079    23                      incss  hl
007a    22 02 08                ld.nnhlfillp
007d    f1                      popqq  af      / restore register af
007e    d9                      exx            / restore bc, de, and hl
007f    fb                      ei             / re-enable interrupts
0080    ed 4d                   reti


                                / system initialization
0082                start:
0082    3e 8a                   ldrn   a,CONF / configure port
0084    d3 03                   out.na CONT
0086    3e ff                   ldrn   a,INIT
0088    d3 00                   out.na PA
008a    d3 02                   out.na PC

                                / clear all of ram
008c    3e 00                   ldrn   a,0
008e    21 00 08                lddddnn hl,RAM
0091    77                      ld.hlr a
0092    11 01 08                lddddnn de,RAM+1
0095    01 00 08                lddddnn bc,STACK-RAM
0098    ed b0                   ldir

                                / set up buffer pointers
009a    21 06 08                lddddnn hl,buf
009d    22 02 08                ld.nnhlfillp
00a0    22 04 08                ld.nnhldrainp

                                / reset serial port
00a3    3e 4e                   ldrn   a,TMODE
00a5    d3 05                   out.na TSTAT
00a7    3e 37                   ldrn   a,TCOMM
00a9    d3 05                   out.na TSTAT

00ab    31 00 10                lddddnn sp,STACK        / load stack pointer
00ae    ed 56                   im1                     / set interrupt mode 1
00b0    fb                      ei                      / enable interrupts
00b1    c3 42 01                jpnn   _main            / enter the C program

                                / Put a character out through the serial port
                                / The char in to be output is in A register
                                / B register destroyed
00b4                lputc:
00b4    47                      ldrr   b,a    / save
                                / wait on buffer empty
00b5    db 05       out1:       ina.n  TSTAT
00b7    e6 01                   andn   UTBE
00b9    28 fa                   jrze   out1
00bb    78                      ldrr   a,b
00bc    d3 04                   out.na TDATA
00be    c9                      ret

                                / Called from C.
                                / Return char in buffer if available or -1
                                /  if the buffer is empty. Check the queue pointer
                                /  fillp against drainp.
                                /
                                / If fillp > drainp, return char pointed to by drainp
                                /    and increment drainp.
                                / If fillp = drainp and drainp != buf, we have returned
                                /    the buffer is empty. Reset both pointers to "buf"
                                /    and return -1. Also send a GO to the host.
00bf                _getc:
00bf    2a 02 08                ldhl.nnfillp            / hl = fillp
00c2    ed 5b 04 08             lddd.nnde,drainp        / de = drainp
00c6    af                      xorr   a                / clear carry
00c7    ed 52                   sbchlssde               / fillp-drainp
00c9    20 23                   jrnze  get2             / z clear if fillp != drainp
```

Listing 2 continued:

```
                                / drainp = fillp. Now check drainp against "buf"
00cb    21 06 08                lddd nn hl,buf          / hl = buf
00ce    af                      xorr    a               / clear carry
00cf    ed 52                   sbchlssde               / buf-drainp
00d1    28 17                   jrze    get1            / z set if drainp = buf

                                / drainp = fillp and drainp != buf, so
                                /   return -1 and reset both pointers to buf.
00d3    11 06 08                ldddnn de,buf           / drainp=fillp=buf
00d6    ed 53 04 08             ld.nndddrainp,de
00da    ed 53 02 08             ld.nnddfillp,de

                                / If stopf = 1 send GO
00de    3a 01 08                lda.nn stopf
00e1    fe 01                   cpn     1
00e3    20 05                   jrnze   get1    / z clear if stopf = 0
00e5    3e 11                   ldrn    a,GO
00e7    cd b4 00                callnn  lputc

                                / no char avail. Return -1
00ea                    get1:
00ea    21 ff ff                lddd nn hl,-1
00ed    c9                      ret

                                / return char from buffer and increment
                                /  drainp.
00ee                    get2:
00ee    1a                      lda.de          / de=drainp. Get char from buffer
00ef    13                      incss   de      / increment drainp
00f0    ed 53 04 08             ld.nndddrainp,de
00f4    6f                      ldrr    l,a     / return char
00f5    26 00                   ldrn    h,0
00f7    c9                      ret
                                / put(sense, assert)
                                / Called from C
                                / The arguments are on the stack at offsets 6 and 8,
                                /   respectively.
                                / "sense" is the one-of-eight code to look for on the
                                /   scan lines.
                                / "assert" is the one-of-eight code to place on the
                                /   processor input.
                                / Both values must be complemented before use.
                                / If the variable "upper" was set in C, assert the
                                /   upper case line.
00f8                    _put:
00f8    21 00 00                ldddnn hl,0
00fb    cd 2d 01                callnn csv
                                / test for upper case
00fe    3a 00 00                lda.nn _upper
0101    fe 01                   cpn     1       / shift?
0103    20 04                   jrnze   p0
0105    3e fe                   ldrn    a,SHIFT
0107    d3 02                   out.na PC

0109    06 04           p0:     ldrn    b,4.    / count

010b    dd 7e 06                ldr.ixda,6.     / arg1: look for this scan
010e    2f                      cpl             / complement
010f    57                      ldrr    d,a     / to d

0110    dd 7e 08                ldr.ixda,8.     / arg2: put this out
0113    2f                      cpl             / complement
0114    5f                      ldrr    e,a     / to e

                                / wait for scan = sense value
0115    db 01           p1:     ina.n   PB      / input Processor B value
0117    ba                      cpr     d       / has the code come up yet?
0118    20 fb                   jrnze   p1      / if not, keep looking

                                / output assert value
011a    7b              p2:     ldrr    a,e
011b    d3 00                   out.na  PA      / val out to Processor A

                                / wait for scan complete
011d    db 01           p3:     ina.n   PB      / input Processor B value
011f    ba                      cpr     d       / look for sense code to change
0120    28 fb                   jrze    p3

                                / unassert lines
0122    3e ff                   ldrn    a,INIT
0124    d3 00                   out.na  PA
0126    10 ed                   djnze   p1      / do it again until b = 0
0128    d3 02                   out.na  PC      / negate shift
012a    c3 3b 01                jpnn    cret    / back to C

                                / register save sequence
012d                    csv:
012d    fd e3                   ex.spiy         / put iy onto the stack and put ret address in iy

012f    dd e5                   pushix          / push ix onto the stack
0131    dd 21 00 00             ldixnn  0       / copy sp into ix
0135    dd 39                   addixpp sp
0137    39                      addhlss sp      / add reset stack pointer from stuff in hl
0138    f9                      ldsphl
0139    fd e9                   jp.iy           / return
013b                    cret:
013b    dd f9                   ldspix
013d    dd e1                   popix
013f    fd e1                   popiy
0141    c9                      ret

0800                    .=RAM
                                / variables in ram
                                / starting at address 800 (hex)
0800    00              nomore: .byte   0
0801    00              stopf:  .byte   0
0802    00 00           fillp:  .word   0
0804    00 00           drainp: .word   0

                                / the character queue
0806                    buf:
0f8e                    .=.+BUFSIZ-HIGHW
0f8e                    highw:
0fa2                    .=.+HIGHW
0fa2    00              topmem: .byte   0
```

Text continued from page 250:

delays are needed for carriage returns, backspaces, and tabs. The carriage-return delay is calculated by multiplying the current print position by a constant and adding the linefeed delay. If this number exceeds 65,535, a second delay must count the difference. The tab delay assumes a nominal 8-character tab width.

A character to be typed is first looked up in the *lcase* (lowercase) array. If it is not found there, the *ucase* (uppercase) array is checked. A character never found is ignored. The row and column indexes corresponding to the character's position in the array are converted by the *bit* array to one-of-eight codes. If the character is found in ucase, the upper variable is set to 1. The two one-of-eight codes are passed to the _put assembly-language subroutine. On return, the C program counts down the previously calculated delay and continues checking the character queue. The program will stop typing when a TYPE_OFF sequence (ESC followed by Control-A) is found in the buffer. Note that typing will not stop immediately if there are characters in the buffer ahead of TYPE_OFF.

Typewriter Setup

I have selected control characters to perform the typewriter's programmable functions. These are found in table 2. It would be helpful to follow an example of their use. To set the tabs and margins, the host sends a TYPE_ON sequence followed by the hexadecimal ASCII (American National Standard Code for Information Interchange) codes 11, 0F, and 12 for "EXPR TABC REP." As explained in the Praxis typewriter operating guide, this sequence will clear all tabs and margins and return the carriage to position 0. Because my program does not calculate a delay for these control codes, the host should wait a second or two before sending more characters. The host can now set the tabs and margins by sending space characters (hexadecimal ASCII 20) to move the carriage to the desired column followed by the control functions MARL, TABS, and MARR as appropriate. Subsequent characters sent by the host will be printed by the typewriter until a TYPE_OFF sequence is found in the queue.

Function Code	Hexadecimal Value	Typewriter Function
RELOC	03	reloc
MARB	04	margin bypass
CORR	05	correction key
HALF	06	half space
MARL	07	margin left
BS	08	backspace
TAB	09	tab
MARR	0b	margin right
LOCK	0c	shift lock
CR	0d	carriage return
OH	0e	½
TABC	0f	tab clear
TABS	10	tab set
EXPR	11	expr.
REP	12	repeat

Table 2: *This table shows control character mapping. I have assigned the special functions of the typewriter to ASCII control codes.*

Conclusions

I have tuned the delay constants in the program for the fastest possible typing speed. However, because I rely on the Praxis typewriter's internal buffer, I run very close to overflowing it. You may have to retune these constants for your particular system speed. Along the lines of improvements, it may be better to sense when the typewriter has finished printing a character by reading the F8 lines that control the mechanics.

One keyboard function I did not implement is the KB-I/KB-II switch. Being a toggle switch, it cannot be pulled like the momentary switches. A relay would do the job nicely.

I am quite pleased with the operation of the typewriter. It may seem that $250 is a lot to spend on a portable typewriter. With letter-quality computer printers costing three to six times as much, however, the Praxis typewriter looks comparatively good. The quality of the type is excellent—crisp characters perfectly aligned.

I have written several driver programs on my host system to manipulate the typewriter. One program sets up tabs and margins and prints a file previously run through a word-processor program. A library of subroutines can be included in other programs to print output on the typewriter. One application is an elaborate checkbook program that uses the typewriter to print out checks. ■

Painter Power

An Electronic Paintbrush for Artists

Chris H. Pappas and William H. Murray
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Binghamton, NY 13902

Painter Power is a high-resolution graphics program that lets Apple II users create paintings on a color screen. Completed paintings may be viewed in a slide show on the color monitor or printed if a screen dump routine is available.

Painter Power allows you to use the Apple II keyboard, game paddles, or a joystick to paint color pictures. You use them to create "brushes" and to move objects around on the "canvas." We recommend, as a minimum, the purchase of a pair of high-quality, noncentering joysticks for the creation of brush shapes. (A noncentering joystick remains in position when released, easing figure and brush creation.) The brush moves across the screen at a predetermined rate of speed: snail, turtle, rabbit, and blitz. You control where the brush goes by the joystick and whether or not the brush is touching the canvas (i.e., painting or not painting).

Painter Power operates in two modes: beginner and advanced. The beginner level is not as powerful as the advanced, which requires time and patience to master. With the beginner level, you can be up and painting in a flash. We estimate that it will take about an hour to master the beginner mode and probably a month of painting to master the advanced mode—it has a lot of features. With either mode, you can really paint creatively.

Beginner Mode

The beginner mode supplies a preformed brush. You can create a different brush by using the brush-create mode and preferably a joystick. You can also control the brush's width and shape in the creation process and, hence, the patterns made with a stroke.

At a Glance

Name
Painter Power

Use
Permits the use of a color television or monitor to serve as a painter's canvas for creating pictures from the Apple's high-resolution mode.

Manufacturer
Micro Lab
2310 Skokie Valley Rd.
Highland Park, IL 60035
(312) 433-7550

Price
$39.95

Features
Contains two modes: beginner and advanced. The beginner mode is easier to use but has fewer options. Both modes allow an artist to select background color and brush colors and shapes. The brush shape can be controlled from the keyboard, game paddle, or joystick.

Format
A locked 5¼-inch floppy disk.

Computer
Designed to run on an Apple computer with a 16-sector disk drive. Requires 48K bytes of memory and Applesoft in read-only memory or a language card.

Documentation
44-page manual

Audience
Anyone wishing to create color paintings for personal pleasure or presentation.

Once satisfied with the brush shape, you change to paint mode and select the background color for the canvas. Your choices are green, purple, white, orange, blue, and black. As with oil paints, you can paint over previous work. This lets you experiment with a shape on the canvas before making it a permanent part of the picture.

If unsatisfied with a painting, you can "purchase" a new canvas by hitting the "C" key and clearing the pattern. Masterpieces can be saved on disk for a future showing.

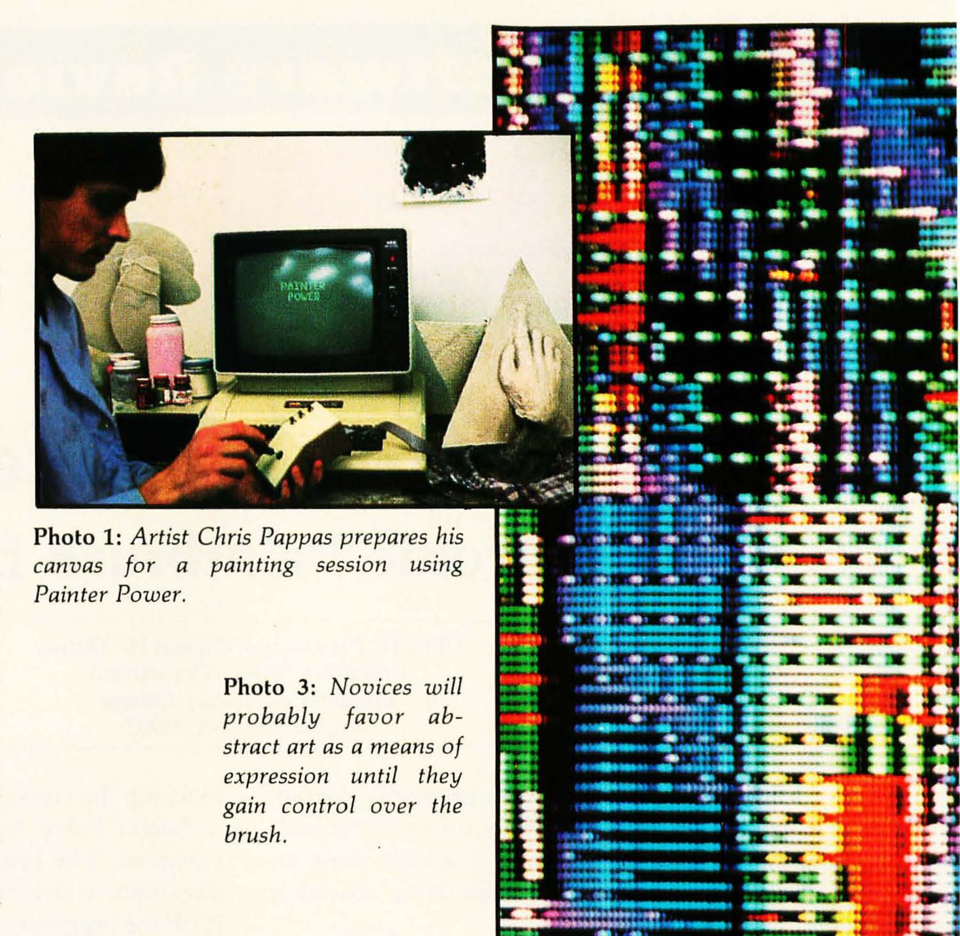


Photo 1: *Artist Chris Pappas prepares his canvas for a painting session using Painter Power.*

Photo 3: *Novices will probably favor abstract art as a means of expression until they gain control over the brush.*

Advanced Mode

While the beginner mode will get you painting with a minimum of frustration, the real power of Painter Power lies in the advanced mode. It uses the keyboard, as many as four paddles or a joystick, two high-resolution screens (one for brush making and the other for the painting), and four text lines (for controlling the display) at the bottom of the canvas. A wraparound mode extends the canvas from −256 to +255 points in both directions on the beginner canvas to −512 to +511 points on the advanced canvas.

Two vectors on the text screen show the brush's location on the high-resolution display. The form is −100, +70, where −100 is 100 points left of the starting position and +70 is 70 points above the starting position of the brush. While the brush is painting, these numbers are constantly changing, which helps you position it precisely.

Painter Power lets you design and save as many as eight different brush shapes. A ninth shape, called Quickstroke, is available from among the eight original brushes. With Quickstroke, predefined patterns may be selected and painted on the canvas.

With the advanced mode, you can create patterns with mathematical functions. These shapes include circles, flower petals, spirals, ellipses, and sine or cosine waves. You have control over the size, scale, number of repeats, and beginning and ending angles.

Slide Shows

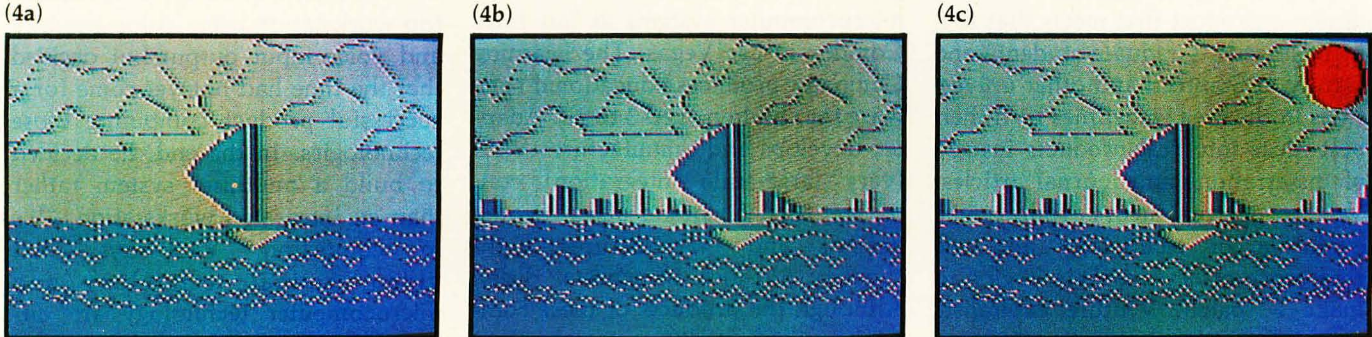
The Slide Show option is a creative feature of this software. As many as 50 paintings can be shown along with optional titles. Each slide can be viewed for as long as one minute. The presentation is automatic. Once created, a slide show can be run by typing "N" when prompted. You and your loyal admirers can then view the gallery as many times as you like.

Painter Power's Weaknesses

A major disadvantage of Painter Power became obvious when we tried to make a backup copy: the disk is locked. Shortly thereafter, we couldn't get the joystick to function correctly in the beginner mode. It took a letter, a telephone call, and two weeks to get a new disk. Replacements cost $5 after the 30-day warranty period. Can you imagine the frustration an artist would feel if the joystick failed to operate in the middle of a masterpiece? It would be like running out of paint and having to wait for a new shipment.

Another disadvantage was a lack of total control over the brush. We had several frustrating moments when the brush took off on its own across the canvas. This disad-

Photo 2: *The preformed brush (lower left-hand corner) is moved about the canvas by means of the keyboard, game paddles, or a joystick. Color changes are made with keyboard commands.*



vantage probably becomes less of a problem with experience in using the system.

Conclusions

Despite its drawbacks, Painter Power is a real bargain for the price. It is a well-documented program with many deluxe features. ■

Photo 4: *A typical sequence in painting a scene. In 4a, the sailboat, water, and clouds were painted and saved on disk. In another work session (4b), the New York skyline was added to the scene. Finally, the sun was added to give contrast to the picture (4c). During the creation of these scenes a "mistake," such as an oblong sun, could be removed and repainted without destroying the whole canvas.*

Ferment in Silicon Valley

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There is as much ferment—of a different kind—in Silicon Valley as in all of California's wine lands. Just as the soil and climate in Napa Valley are ideal for growing varietal grapes, the dynamism of Silicon Valley is ideal for starting high-technology companies.

Engineers and programmers will move from an established company whose top management decides against developing their ideas into products to an environment favorable to their work. Middle managers who believe their companies are neglecting a certain market segment look discreetly for engineers who can design a product that meets that segment's needs. Graduate students and faculty at Stanford and other universities in the area sometimes turn their best ideas into real products instead of dissertations and journal articles. Veteran entrepreneurs follow the evolution of technology and the emergence of new markets, trying to make a match. Venture capitalists patrol the towns along routes 101 and 280 in search of bright, energetic people with original ideas and plausible goals. In recent years, venture-capital firms have gone beyond bankrolling people who come to them with ideas; these firms now study the marketplace in search of unfulfilled needs and then look for someone to start a company that will make a product that meets those needs. It's no wonder that new companies are constantly bubbling to the surface.

How do companies get started? Profiles of four newcomers reveal different strategies.

A sampling of a few new companies illustrates the variety of start-ups in Silicon Valley. Victory Computer Systems introduced two new microcomputer systems at last fall's Comdex in Las Vegas. The Learning Company produces educational software for children aged 3 to 13. Adaptec develops and manufactures VLSI (very large-scale integration) controllers for Winchester disks. Evotek designs and manufactures high-capacity 5¼-inch Winchester disks. Although the products of these companies represent different technologies aimed at different markets, all four companies show the same imagination and drive and face similar challenges.

Victory Computer Systems

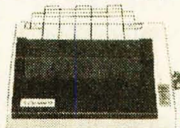
Roger Vass, a co-founder of Altos Computer Systems of San Jose, California, had been walking the floors of computer shows for some time wondering what kind of system he should build. He knew that the microcomputer market was crowded, and as a former vice-president of marketing for Altos, he knew that he had to identify the right market niches before proceeding to design.

Vass's ideas gelled sometime between the Dataquest conference on the microcomputer industry held at Silverado, California, in January 1982 and the Hanover Fair held in West Germany the following April. Vass had considered building a desktop workstation using color graphics and voice input/output but decided that the time had not yet come for a successful product combining those technologies. In the end, he decided to build a multiuser system rather than an integrated workstation. "It's my conviction," Vass says, "that video-terminal technology and microcomputer technology are different. I'm not sure you can do a good job with both at the same time."

Instead Vass chose to build a "clustered, shared-resource computer with an unburdened 16-bit host." Victory's computers use not only a 16-bit microprocessor, but also a 16-bit hard-disk controller and an 8-bit

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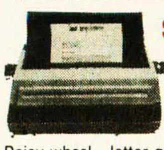
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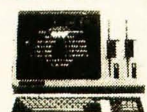
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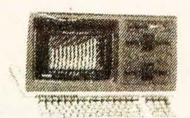
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microprocessor to handle input/output for each serial channel.

Once he made his decision, Vass moved quickly. Vass and Bill Daugherty, now vice-president for finance, used Visicalc to make projections and a business plan. In July 1982, Vass gave consultants the first contracts for the design of the two systems he planned to build. In August, Vass added electronics designer Jim Willott, who formerly worked at Zilog and Altos, to the Victory staff. Willott developed and oversaw further consulting contracts for the design of the Victory computers. Victory Computer Systems, which was not incorporated until September 7, 1982, announced its two systems at Comdex late in November.

The two Victory series of microcomputers differ only in the central-processing-unit board. Both systems use the high-speed VME (versa module European) bus, derived from the Motorola Versabus and adopted by Motorola, Mostek, Thompson, Philips, Signetics, and other companies. (Victory expects to market 60 percent of its computers in Europe, the other 40 percent in the United States.) Both systems include integral fixed Winchester disks holding 20, 40, or 85 megabytes of data, and integral tape backup. Both systems can run CP/M on 4 terminals while running a 16-bit operating system on another 12 terminals. Both systems will be capable of running new friendly software that requires advanced graphics capabilities. The C. Itoh terminals, customized to Victory specifications, have options for color graphics with 640 by 480 resolution.

The Victory Spirit Series of computers is based on Intel's 80186 and runs operating systems from the Digital Research family. Victory made both choices in light of the many independent software development projects currently in progress for that hardware/software combination in the business market.

The Factor Series is based on the Motorola 68000 microprocessor and runs the Unisoft Uniplus System 3 Unix operating system, which includes some of the enhancements to Unix developed at the University of California at Berkeley. The Factor Series targets the industrial-applications and process-control market. Because Vass sees that market as "software-development intensive," he chose the Unix operating system and its noted virtues as an environment for developing software.

With a couple of important qualifications, Victory Computer Systems is following the classic model of raising venture capital. In this model, start-up companies raise capital in three rounds. The first round is for organizing the company and designing a product. If that goes well, the outside capitalists will agree to finance a second round, which is for building a prototype. After the prototype is completed and working, the venture capitalists examine the existing competition and decide whether to invest in the third round, which involves manufacturing and distribution. In exchange for venture capital, the founders of start-ups surrender a percentage of their companies. Victory Computer Systems differs from this model in that its management team was able to put in a substantial amount of its own money and Vass was able to move into production much faster than the usual start-up. As well, Vass's background at Altos—his successful "track record"—reduced the percentage of the company that the founders had to surrender to the venture capitalists.

The greatest impetus in the founding of Victory Computer Systems was Roger Vass's willingness to use his own assets as capital. Now the company has opened new manufacturing facilities in the Berryessa industrial park in San Jose. The sales and executive offices remain in Gateway Place in the same city.

The Learning Company

Ann Piestrup, founder of The Learning Company, is an educational psychologist who spent 10 years studying children's thought and language and especially the problem of how to maximize learning of basic

skills. She decided to develop educational software "when I first saw that computers could do colorful, musical, playful things." Piestrup's studies had shown that active learning is the key to understanding, but when she looked at existing educational software for microcomputers, she saw little that actively involved the children or that exploited the computer's ability to generate immediate feedback using color graphics. In December 1979, Piestrup expressed her views and goals to Carolyn Stauffer, former director of the Apple Education Foundation. As a result, the foundation gave Piestrup an Apple II Plus with a language card, graphics, and Supertalker and added $1000 so that she could hire a programmer. Piestrup founded Advanced Learning Technology, a sole proprietorship, in order to receive the grant.

Piestrup and another expert on learning, Barbara Jasinski, designed the first program, specifying every screen on graph paper to show exactly what the low-resolution color graphics should do. Alice Chiang, a consulting programmer to International Business Machines, turned the specifications into an executable program. (Jasinski is now active in another new educational software company called Stepping Stones.)

Piestrup used the company's early experience as the basis for a proposal to the National Science Foundation and the National Institute of Education. Those two organizations were jointly awarding nine grants to both profit and nonprofit organizations for the advancement of the use of computers in education. Piestrup's proposal won a grant of $130,000 and she founded The Learning Company to receive it.

At that stage, Piestrup brought in Dr. Teri Perl, a mathematics educator, and Warren Robinett, who has a master's degree in computer science from the University of California, Berkeley, and was a member of the original group of programmers at Atari. The programs resulting from the collaboration of Perl, Piestrup, and Robinett during the year's funding from the NSF/NIE grant are in the public domain, but they convinced many people that The Learning Company's approach to educational software would make for commercial success.

Among those convinced were Tom Whitney, who formerly worked at Apple Computer Inc., and Jack Melchor of Melchor Venture Management in Los Altos, California. The Learning Company raised $300,000 in January 1982 from the Los Altos venture-capital firm and individual investors. Since then the company has grown to a staff of 14, three of whom are programmers. The Learning Company employs outside subcontractors as well. By January 1983, TLC had developed seven educational programs for children aged 3 to 13. The programs all use color graphics and are interactive, self-pacing, nonviolent, and easy for children to use on their own. Reception has been quite favorable. Both Apple and Atari market TLC products, and TLC has signed with 14 distributors, including Softsel, Micro D, and Bell & Howell. TLC is now in

the enviable position of deciding whether to accept a second round of *venture-capital* financing. TLC may not need more outside money.

Adaptec

Adaptec was started to design and manufacture LSI circuits for producing inexpensive high-performance hard-disk controllers for microcomputers. Adaptec's founders came from large companies. Larry Boucher, Adaptec's president, spent 10 years at IBM working on high-performance input/output systems. Boucher left IBM to join Shugart Associates in 1979 and was soon responsible for developing integrated circuits and designing disk controllers. Boucher and Bernie Nieman, then an engineering manager at Shugart, developed the Shugart Associates System Interface (SASI) for connecting small computers and small hard disks. SASI has since been proposed as the ANSI (American National Standards Institute) Small Computer Standard Interface (SCSI).

Boucher's decision to found Adaptec was not instantaneous. "It grew," he says, "out of an inability to do what I wanted to do within the organization that I was working in." Shugart Associates was emphasizing disk drives and Boucher's primary interest lay in disk controllers and custom LSI chips.

When Boucher founded Adaptec early in 1981, he brought in Nieman and another former employee of Shugart Associates, Wayne Higashi, who had been manager of design assurance. This group of three ex-Shugart employees brought in John Hulme, an expert in LSI technology who had worked as an engineer and manager of semiconductor projects at Fairchild, Hewlett-Packard, and Siliconix.

Boucher, Nieman, Higashi, and Hulme agreed to contribute $15,000 each and to work for one year without salary. They took some space in an old converted apartment building in Campbell, west of San Jose, and set about designing their first hard-disk controller. Ignoring noise from rock-band rehearsals and cabinet makers in adjoining apartments, Adaptec's founders worked hard using their own S-100 personal computers and some surplus breadboards to develop a prototype. In the same period, Boucher refined Adaptec's business plan. "We did the numbers manually," Boucher recalls, "but we used Wordstar running on an S-100 system to write the plan." Within six months of the company's beginning, the prototype controller and the business plan attracted $1,650,000 in venture capital.

In the two years since its founding, Adaptec has grown to a staff of 20 and expects to have 40 employees before the end of 1983. The firm now has its headquarters in Milpitas, California. Adaptec has received another $4,300,000 in equity funding from four venture-capital firms: Lawrence, WPG Partners, of San Francisco; Technology Venture Investors, Menlo Park; New Enterprise Associates, San Francisco; and Merrill, Pickard, Anderson & Eyre, San Francisco.

Forecasting sales of $10 million in 1983, Adaptec produces LSI products for Winchester-disk-drive control: chip sets for use in high-performance, multitasking applications and a single controller chip for use in personal computers. According to Phil Devin, an Adaptec product marketing manager, the company has "had evaluation-unit orders from all the major microcomputer companies and some of the major drive manufacturers." The Winchester Controller Chip will cost $52 in large quantities in 1983 but that price is expected to fall to $36 in 1984.

Evotek

Sometimes venture capital comes through acquaintances. George Brennan, who has held senior management positions at Memorex, Honeywell, and the Marshall Electronics Group, knew some of the people at Ibis Systems in Los Angeles. Ibis makes high-capacity hard disks using thin-film media for use with IBM 3300 series computers. Brennan saw a need for high-capacity, high-performance 5¼-inch Winchester disks to be used with microcomputers, and he approached Ibis about licensing its technology for the microcomputer market. Ibis agreed and soon Brennan was developing a business plan for Evotek.

After people at Ibis looked at the plan, they asked Brennan if they could send it on to two venture-capital firms that backed Ibis. These were the Hillman Group, reputed to be the largest of the venture-capital firms, and Rothschild Inc., of New York City. Brennan agreed and soon both venture firms backed Evotek, with the Hillman Group putting up $3 million.

Evotek was incorporated in June 1981 with George Brennan as president. Burton Sisco, another founder and the vice-president of engineering, had worked with Brennan at Memorex. Gordon Steel, *vice-president* of finance, and Edmund Turek, vice-president of operations, also had experience at large companies.

Turek sought candidates for employment at Evotek who had experience designing 14-inch Winchester disks. From the beginning, Evotek's goal was to bring the technology for large hard disks down to the 5¼-inch size commonly used with microcomputers.

By June 1982, Evotek had prototypes ready to be exhibited at the National Computer Conference in Houston. Evotek then had 50 employees. In late November 1982, Evotek showed "preproduction" disk drives developed from the prototypes, and in January 1983 Evotek began shipping a family of hard disks that use thin-film media to store from 7.8 to 51 megabytes. The company now occupies a 50,000-square-foot building in the Sutter Hill-Fremont Business Center, a business park in Fremont, 10 miles north of San Jose. The number of employees had grown to 160 by February 1983.

Looking for Venture Capital?

People looking for sources of capital may find the *Directory of Venture Capitalists* useful. The publication is available for $20 from the Western Association of Venture Capitalists, Building 2, Suite 260, 3000 Sand Hill Rd., Menlo Park, CA 94025. ■

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NAPLPS: A New Standard for Text and Graphics

Part 4: More Advanced Features and Conclusions

A standard way to encode color mapping and animation, closing with some predictions on how NAPLPS will be used by personal computers.

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This is the fourth and final part of this series of articles on NAPLPS, the North American Presentation-Level-Protocol Syntax, a new communications standard for encoding both textual and graphics information. With this standard, graphics information can be sent from computer to computer, or from peripheral to peripheral, with little regard to inherent differences in the display capabilities of the various machines available. Such a standard will be particularly important for proposed mass-market data-communications systems such as videotex.

The first part of the series presented an overview of NAPLPS. The second part gave a detailed analysis of its basic features. And last month, some of the advanced features of NAPLPS were discussed. This month I will continue that discussion and conclude with some predictions about the future of NAPLPS.

About the Author
Jim Fleming is a member of the ANSI X3L2 Committee on Character Sets and Coding. He is an independent consultant specializing in interactive computing systems.

These predictions are based on the premise that personal computing has *not* yet reached the majority of people in the world. For that to happen, personal computers must be very easy to use. Those readers who may be dreaming about the day when everyone will be assembling S-100 kits and toggling in bootstrap programs should probably reassess their thinking.

INDEX	COLOR		
	RED	GREEN	BLUE
0	0.2	0.3	0.0
4	0.0	0.0	0.0
5	0.5	0.8	0.8
6	0.0	0.8	0.8
25	1.0	1.0	1.0
26	0.5	0.5	0.5
27	0.6	0.0	1.0
31	0.0	1.0	0.0

Figure 1: *A typical color table used with color modes 1 and 2 in NAPLPS. Each index value corresponds to a specific color. Note that the index values are arbitrary and that no index value appears more than once. Each color is represented as a mixture of the primary colors red, green, and blue.*

Advanced Color Capabilities

As was mentioned in part 1, NAPLPS supports a variety of color modes. The most primitive one (mode 0) is quite portable and will be used in the majority of applications. As was previously described, colors are specified in color mode 0 by indicating the relative amounts of red, green, and blue that should be mixed to form the desired color.

Color modes 1 and 2, however, use a technique called *color maps* or *color tables*. As shown in figure 1, a color table is a set of indexes and their corresponding colors. These are tied together using the Set Color and Select Color commands. As can be seen in the figure, a given mixture of primary colors can be used more than once, and all the indexes do not have to be used. Note that the index value does *not* have any direct relationship with a hardware *drawing value* at this point.

In order to make an entry in the color table, you must first use the Select Color command to specify a

certain index (see figure 2). This index value is encoded in the byte or bytes following the command and usually ranges from 0 to 63, although indexes as high as 16,777,215 can be encoded. After an index is chosen, you can then use the Set Color command to specify the mixture of red, green, and blue values that should be associated with the index.

When you want to select a color for drawing in color modes 1 and 2, you must specify the index for that color—not the actual color. The primary difference between modes 1 and 2 is that mode 2 allows you to specify a background color for text characters.

As shown in figure 3, when a picture is drawn into display memory, a drawing value is allocated to each index. This value is written into the display memory. The color information currently associated with each index is put into a hardware register associated with each drawing value, and anything drawn with that display-memory value will have that color. Note that a display value is allocated to an index only when drawing occurs. Also, each display value is allocated to only one index.

In order to create blinking and animation effects, the color associated with an index can be changed using the Select/Set sequence de-

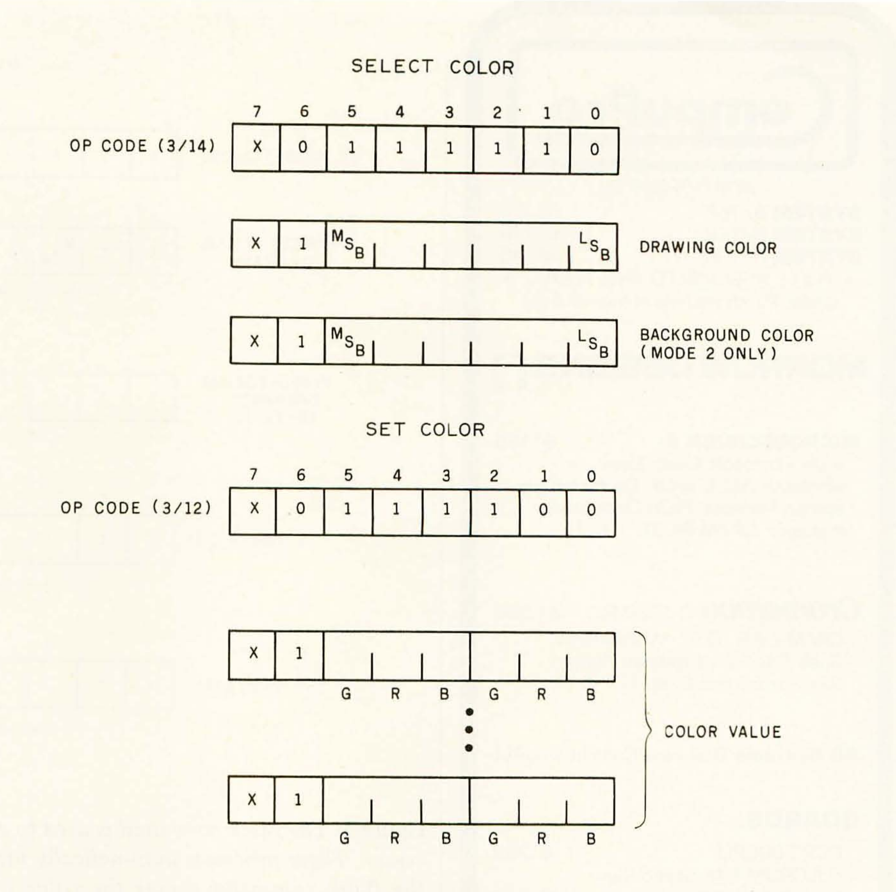
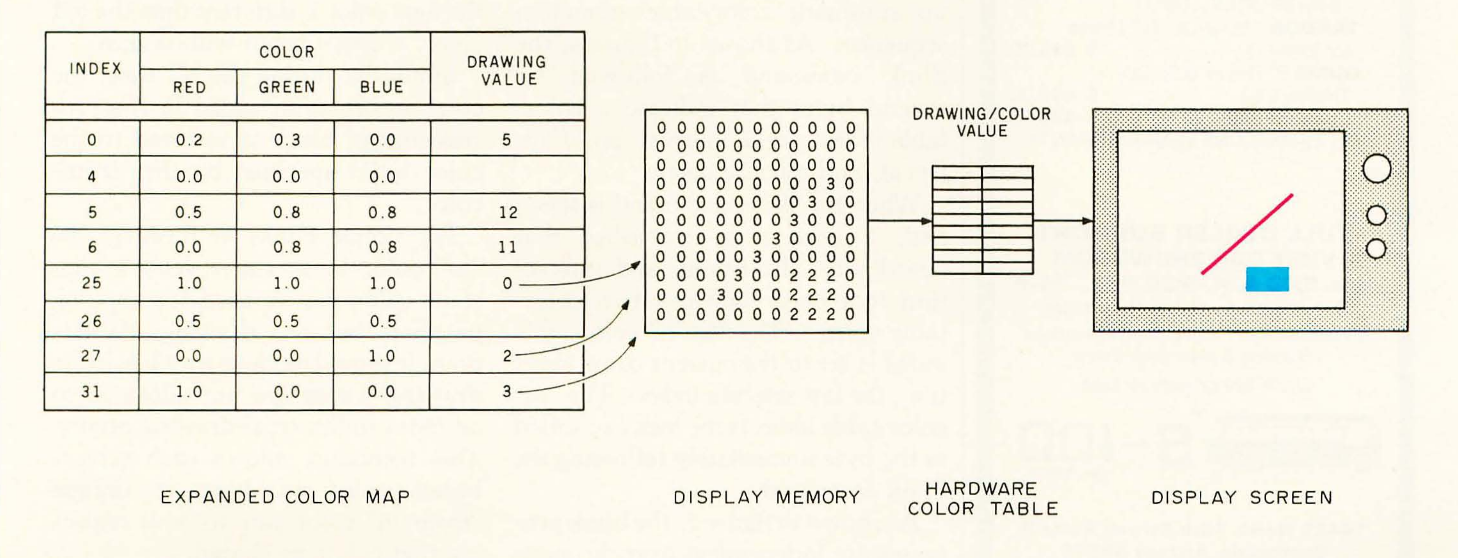


Figure 2: *The Select Color and Set Color commands used to specify a color-table index value and a red, green, and blue mixture, respectively. (The codes 3/14 and 3/12 are an alternate way of indicating the hexadecimal numbers 3E and 3C.) In color mode 2, two indexes can be specified in the Select Color command if a background color for text is desired. The normal sequence used to load the color table is to first select an index and then set a color for that index. These actions cause a relationship to be established between an index value and a color. After a table is set up, each set color can be used by using the Select command. Also, the color associated with each index value can be changed by using another Set Color command.*



INDEX	COLOR			DRAWING VALUE
	RED	GREEN	BLUE	
0	0.2	0.3	0.0	5
4	0.0	0.0	0.0	
5	0.5	0.8	0.8	12
6	0.0	0.8	0.8	11
25	1.0	1.0	1.0	0
26	0.5	0.5	0.5	
27	0 0	0.0	1.0	2
31	1.0	0.0	0.0	3

Figure 3: *A typical color-table implementation. Note that special color-map hardware is required. The drawing value is the one used when drawing occurs in the display memory. It is an index into the hardware-based color map.*

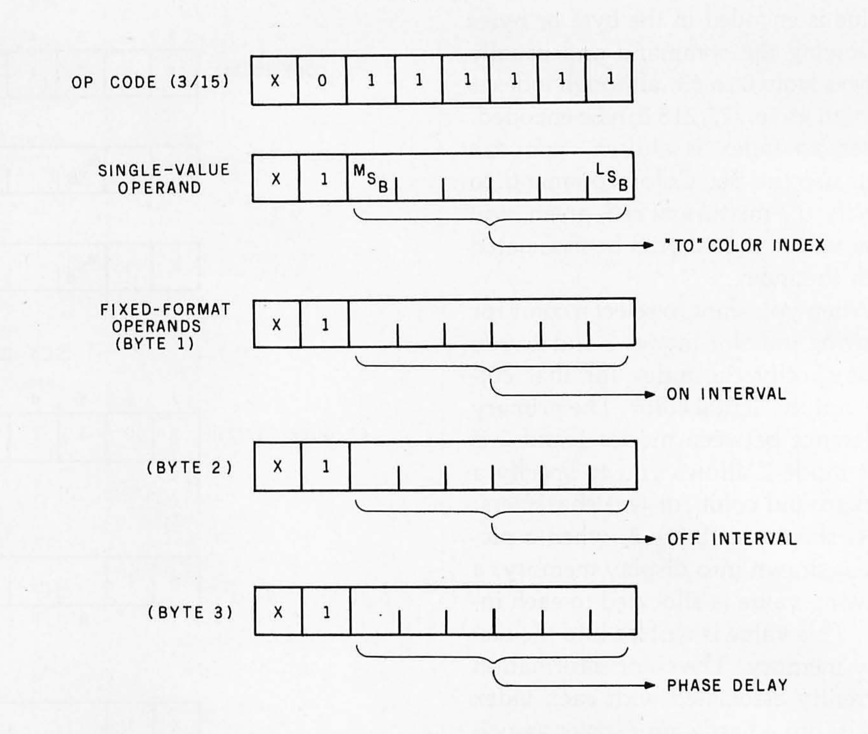


Figure 4: *The Blink command is used to establish one or more asynchronous blink processes. These processes automatically modify the contents of the color map. In short, the Blink command causes the color of the current color index to be temporarily changed to that of the "to" color index. The on, off, and phase-delay times are specified in 1/10-second resolution, which allows this system to be compatible with both North American (60 frames per second) and European (50 frames per second) television systems. These times are used to control how often the color map is modified.*

scribed above. This change will cause everything on the display screen that has been drawn with that value to change color.

Color-Table Animation

The Blink command is used to set up automatic color-table animation sequences. As shown in figure 4, the Blink command is followed by several bytes that indicate a color-table index, an *on* interval, an *off* interval, and a phase delay.

When the Blink command is specified, a *process* is established that coordinates the timing and interaction that occur between two color-table entries. The "from" color-table index is set to the current color index (i.e., the last selected index). The "to" color-table index is the index specified in the byte immediately following the Blink command.

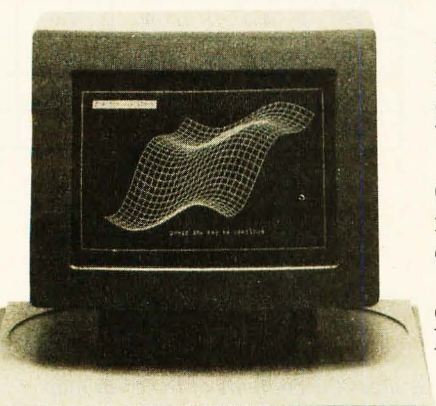
As shown in figure 5, the blink processes are independent asynchronous activities that copy values from one entry in the color table to another. During the on interval, the color corresponding to the index specified by the "from" color is saved in an area of memory called the *process-control block*. Then the color corresponding to the index specified by the "to" index is copied to the "from" index. If the new color is different than the old color, a visual result will be seen.

Similarly, during the off time, the color information saved in the process-control block is restored to the color index specified by the "from" color.

For simple blinks or flashing, the "to" color index can specify a constant color that is used for copying purposes but not drawing. At this point it should be clear why hardware drawing values are not allocated to an index until actual drawing occurs. This technique allows each screen-based color to have a unique "from/to" color pair without requiring that colors be shared.

If you are following carefully, you will note that, at the beginning of the

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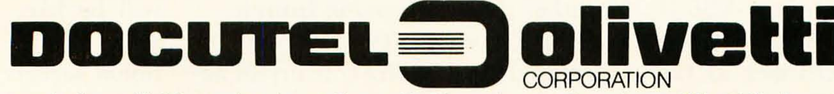
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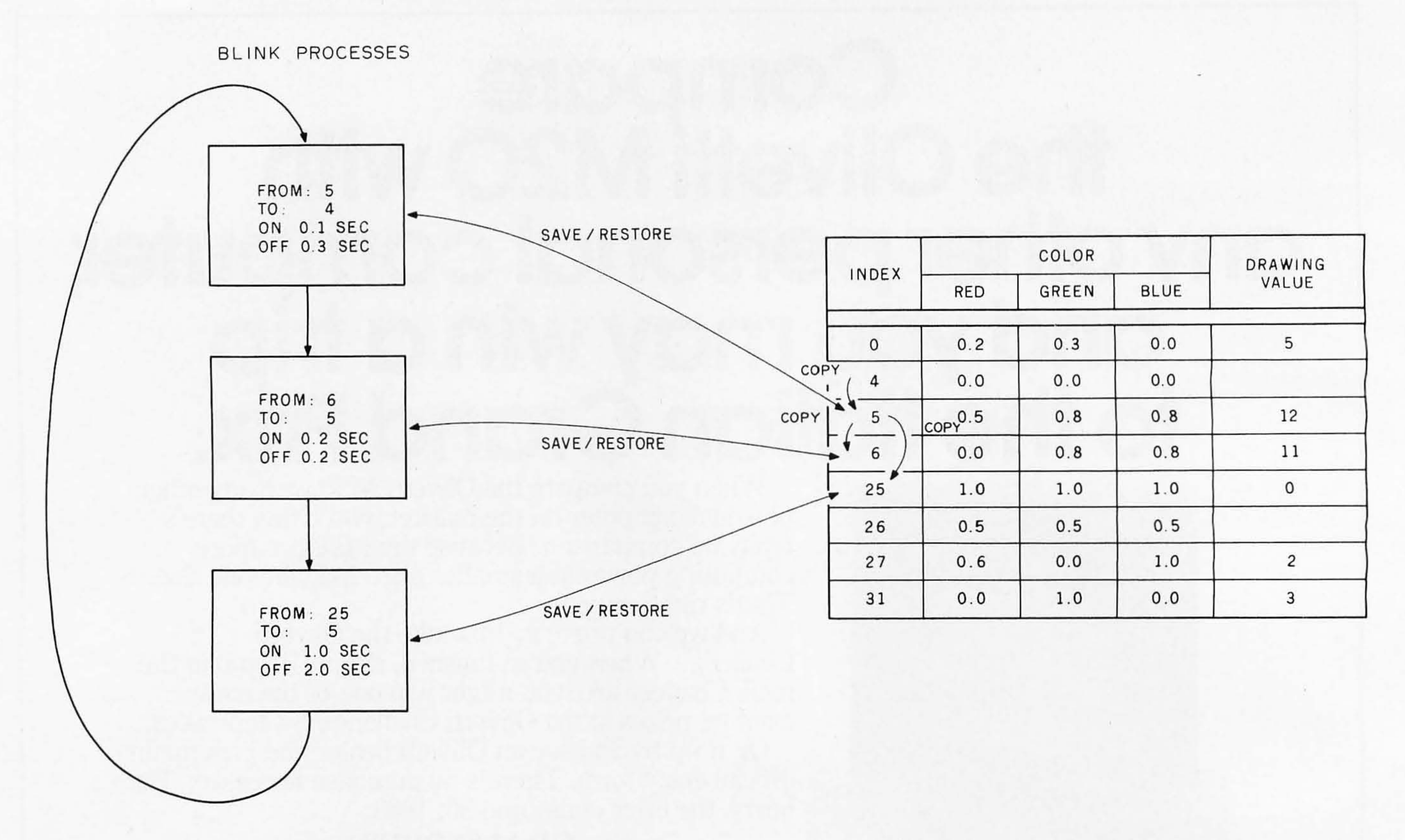
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INDEX	COLOR			DRAWING VALUE
	RED	GREEN	BLUE	
0	0.2	0.3	0.0	5
4	0.0	0.0	0.0	
5	0.5	0.8	0.8	12
6	0.0	0.8	0.8	11
25	1.0	1.0	1.0	0
26	0.5	0.5	0.5	
27	0.6	0.0	1.0	2
31	0.0	1.0	0.0	3

Figure 5: *An example of three blink processes used together. The first process saves the contents of the color map at index 5 and then copies the contents of index 4 into index 5. After 0.1 second, the original contents of index 5 are restored for 0.3 second. The second process saves the contents of the map at index 6 and copies the contents of index 5 into index 6. Note that the second process can copy the contents of index 5 during the time it has been changed by process 1, causing a variety of effects. The third process, which runs very slowly, saves the contents of index 25 and also copies the contents of index 5 into index 25. When changes are made to the colors in indexes 5, 6, and 25, the corresponding hardware color-map registers 12, 11, and 0 are changed, causing visual changes to the screen.*

on time, the color in the "to" color index is copied to the "from" color index. This copy is made independently of any blink activity that may be set for the "to" color. Thus, this copying could occur during a time when the "to" color has been changed by another blink process. The result is that multiple blink processes can be set up to allow colors to ripple around the color table in regular and irregular patterns. These patterns can be used to produce dramatic animation effects under full control of the terminal and without the need for host interaction.

These animation effects, plus the other features described in the previous articles, should establish NAPLPS as the most extensive information-exchange protocol available. As time goes on, it is expected that NAPLPS will replace ASCII (American National Standard Code for Information Interchange) as *the* standard for information interchange. As this occurs, almost every area of computing will be affected. In order to prepare for this impact, we need to look into the future to see how NAPLPS will help shape the world.

Predictions and Conclusions

If one sits back and attempts to predict the future of personal computing and information exchange, some obvious predictions come to mind:

1. Integrated text and graphics will be essential in all visual information exchange.
2. Personal computers must be designed to be so easy to operate that a casual user can begin doing useful things immediately.
3. A personal computer will be used as a *link* to the rest of the world rather than a *diversion* from it.
4. People's efficiency will be increased by allowing concurrent activities.
5. The average personal computer user will be more of a *consumer* than a *producer*.

It should be noted that I have said nothing about the size of memory chips or the density of disk drives. These predictions involve only functionality and the user's view of computing capability. I am a firm believer that the consumer will be the ultimate decision maker when the fate of the personal computing field is decided. These users will make these decisions based on what they see, hear, and touch. They will not make their decisions based on how many chips are in a box or whether interrupts are enabled during DMA disk transfers.

Using these predictions and a little imagination, we can hypothesize what the ultimate personal computer will be like. Figure 6 illustrates my view of such a machine. Four *functional servers* are clustered around a central switching, control, and com-

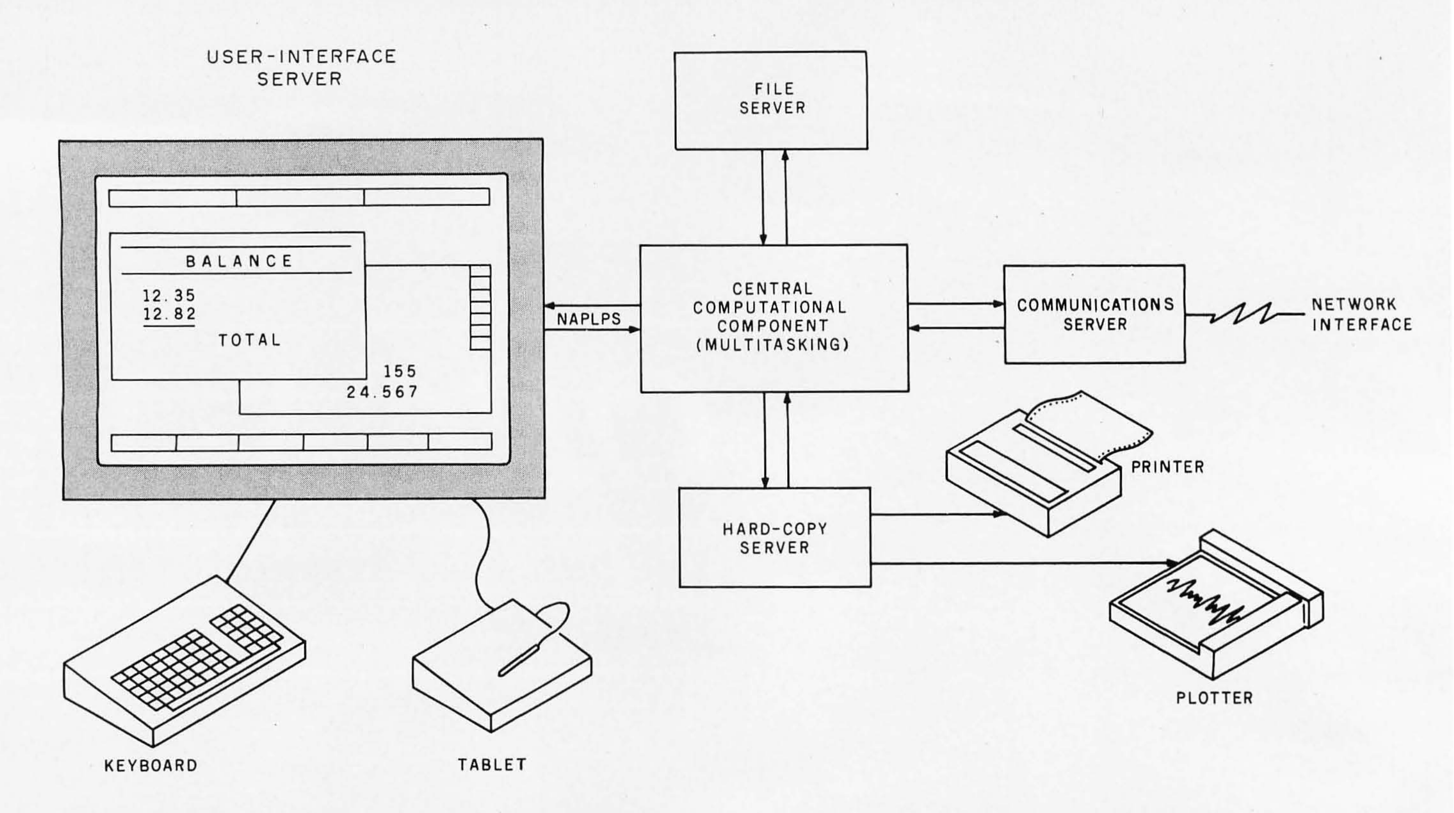


Figure 6: *The ultimate distributed personal computer system for the serious user. Each of the components is an independent entity, each with the power of a typical personal computer available today. The diagram illustrates functionality and does not necessarily imply physical partitioning. NAPLPS is the language used between all components, especially between the User Interface and the Central Computational Component. The User Interface may be able to run a variety of local screen-based text and graphics editors without informing the Central Computational Component.*

putational unit. These four functional servers are *not* meant to indicate peripherals hanging on a microcomputer. In fact, they may instead be integrated into one unit. To put things into perspective, I imagine that each of the functional servers would have the complexity equal to or greater than that of an IBM Personal Computer.

The Hard-Copy, Communications, and File Servers are straightforward. Ideally, the Hard-Copy Server would support integrated text and graphics in high-resolution black and white. Color hard copy would be desirable, but I could probably live without it. The Communications Server would provide all links to off-site services through modems and local networks. The File Server would provide the typical storage and retrieval functions. Features such as automatic redundancy and backup might be transparent to the user. Database-management capabilities could be built into the File Server, which would be responsible for organizing the database in the optimum way based on the user's answers to certain queries.

The User-Interface Server would be an extremely high resolution color-graphics display with a variety of user-input devices. All input editing would be handled by this server. The user should be able to enter text and graphics with equal ease. The ability to point to objects on the screen should be available from any of the input devices. And the User-Interface Server should be able to support multiple *windows*, representing various concurrent activities currently in progress.

The Central Computational Component would be a multitasking system with the computational capability similar to most multiuser timesharing systems. A process (or task) would be active for each window in use in the User-Interface Server. Additional processes could be created to perform tasks for the user.

The Central Computational Component would also be responsible for coordinating all server-to-server interactions. It would also act on the user's behalf if some attention is needed and the user is busy. For example, electronic mail received via the Communications Server would be stored in the File Server without the user becoming involved. The user would be able to retrieve the mail at a later time.

Given this model of an ultimate personal computer, it becomes useful to begin charting an evolutionary path from our current position to this ultimate system. It is obvious in figure 6 that the User Interface must be present in the system before any other component. It is not obvious that the user needs any other component as long as the User Interface has access to a Central Computational Component.

The first step along the evolutionary path is to give the user a User-Interface Server. From that day forward, the user's view of the system begins to form. (The old adage "love at first sight" can be applied to com-

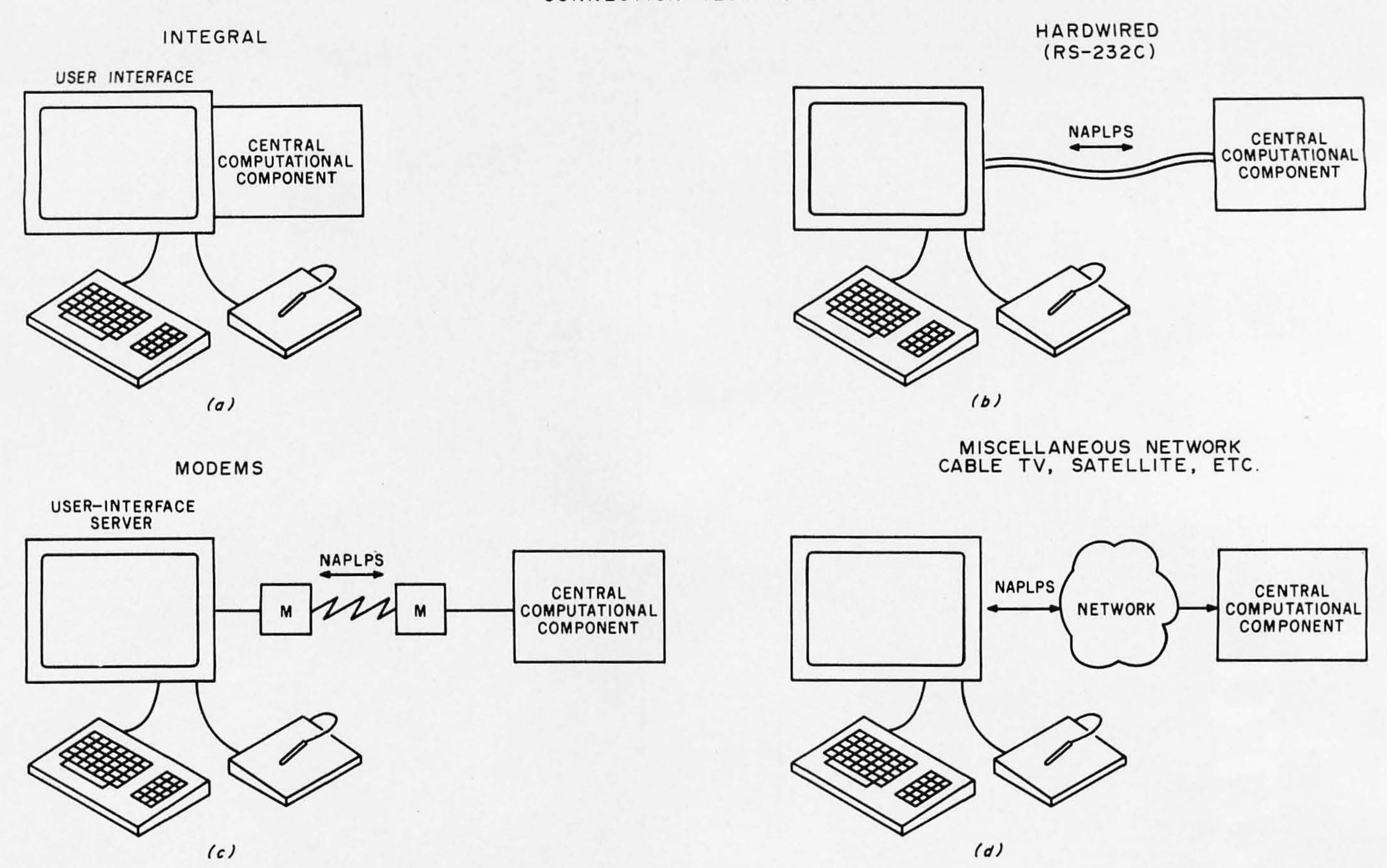


Figure 7: *The User-Interface Server can be connected to the Central Computational Component in a variety of ways. A modem or a network arrangement allows a person to start using a User-Interface Server long before the Central Computational Component is needed.*

puters as well as people.)

Because of this user view that is established, one is driven to give the user as much capability from day one as is economically feasible, even at the expense of not providing other components in the system. This strategy is compatible with the fact that a user will judge a system primarily from interaction with the User-Interface Server.

Once a user is given a User-Interface Server, another serious situation develops: the user will not want to give it up. This implies that when the user eventually obtains a Central Computational Component, he or she will expect the User-Interface Server to work with the new component.

What this all comes down to is that the user should be given the ultimate text/graphics terminal before any other component. The capabilities of this terminal should be standardized, and everything but the kitchen sink had better be available, because the capabilities of that terminal will help shape all future services. And the interface to that terminal must be clearly defined *before* any terminals are given out.

This is where NAPLPS becomes involved—as the text/graphics terminal-interface protocol for the User-Interface Server. As shown in figure 7, a NAPLPS terminal can be connected via a variety of mechanisms to a Central Computational Component. From the first day of use, the user sees a certain set of capabilities and begins to get used to the local editing features available in the terminal. If a user is connected to a host via a modem, all computation and information are obtained from the remote host. The spectacular text/graphics displays are there from the beginning and are not something the user must dream of having.

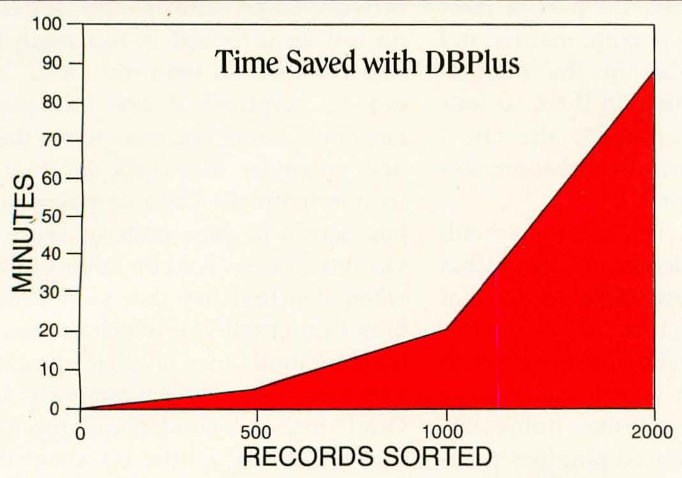
From the host computer's point of view, the user is now a constant, a known entity with a standard interface. Services can be developed with the assumption that the user will not be a moving target. This stability gives the developers of the host system more incentive to develop more services. More services attract more users, and more users of course mean more money, etc., etc.

The user begins to consume the prepackaged information and services. Most users may not want to become programmers or system administrators; they merely want to accomplish a task and get on with the rest of their lives.

At some point in life, however, a user may become more sophisticated and require a dedicated processor. A Central Computational Component

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can be purchased by the user and added to the original User-Interface Server. Many of the services that had been available on the remote host will probably be available on the dedicated processor.

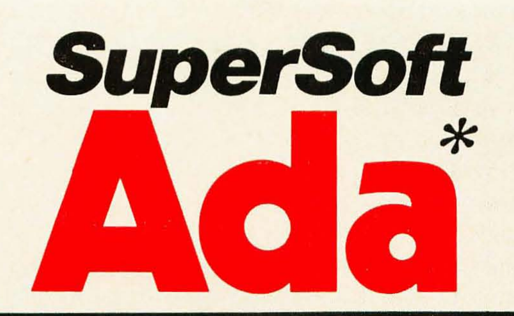
Additional servers could be added to the Central Computational Component as the user desires. One interesting thing to note is that the display capabilities of NAPLPS are such that the Hard-Copy Server can use the same protocol. Also, because the File Server will certainly be able to store NAPLPS, we see that a complete, integrated personal computing system begins to emerge. NAPLPS becomes the common language in the system for information interchange.

The addition of the Communications Server is the mechanism by which a user and personal computer become an entity on a local-area network. Keep in mind that the addition of the Communications Server allows a far more sophisticated system than when the user was *remoted* to a host via an unspecified network. The remoting was done to create the link between the User-Interface Server and the Central Computational Component. The Communications Server was not involved. Figure 7 illustrates this difference.

If I have not lost you completely and you are good at reading between the lines, it should be clear that NAPLPS is a small part of a large, integrated personal computing system. Many of the parts of that system still need to be specified and implemented. Luckily, the part of most concern to users is quite mature and currently available in the marketplace. I predict that in three to four years systems similar to the one I have described will be commonplace in personal computing.

Those of you who are familiar with the various videotex systems that have been proposed may realize that my ultimate personal computer would be fairly compatible with such systems. In most videotex systems, a network of inexpensive home terminals with enhanced graphics capabilities are connected to a host computer. Ideally, the manufacturers of these terminals will design them so that at some later date the user can add the above-mentioned servers.

As I said at the outset of this article, personal computing has not yet reached the majority of people in the world—but someday it will. If you are currently a personal computer user, you should feel honored to be among the pioneers. As the personal computing field begins to evolve into a mass-market, consumer-oriented, network-based information system, do not be surprised if you begin to feel like the odd man out. Also, do not be surprised if one day your neighbors invite you over to see their new computer that costs one fourth to one tenth the price of yours and has access to thousands of services via networking. And do not get upset when you find out that your neighbors cannot tell you which processor their computer uses or what transmission rates their modem supports. Instead, just feel good about the fact that you know a little bit about the language their computer uses to talk to the rest of the world. ■



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- derived types
- enumeration types (no I/O)
- records and selected components

attributes

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control structures

- labels • goto • exit

in out/out mode parameters for subprograms

pragmas

- list • print • optimize
- include • system

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Incomplete, disorganized, and unreadable—that's the way to describe many of today's software manuals. And indeed, what other reaction could there be to the following:

- a 79-page software manual that on page 69 describes "the first thing you will have to do before performing anything . . ."
- a manual that claims the user doesn't need to read other manuals, then, three pages later, refers the user to another manual for necessary information.
- a manual containing sentences such as: "The insert/delete key deletes characters to the left of the cursor position if operated in lowercase and if the Shift key is held down at the same time as pressing INST/DEL all characters to the right of the screen cursor are moved one position to the right with every keystroke and spaces created." (This manual, believe it or not, supports a $500 program.)

Purchasing decisions will be made not so much on program features but on how easy programs are to learn and use.

You don't have to look very far to find such examples, and you don't have to listen very long to hear complaints. Software manuals today are like the bicycle-assembly instructions of yesterday—those notorious documents responsible for unassembled bicycles left rusting away in basements everywhere.

Let's face it: many software manuals are patchwork affairs thrown together at the last minute either by programmers or by technical writers who write too technically. Both assume that the user, given a few scraps of information, can figure out the rest.

This approach certainly saves time and money, but in the long run it is economic suicide. With more computer novices entering the software market, and with similar programs competing for everyone's attention, purchasing decisions will be made not so much on program features but on how easy programs are to learn and use. Thus, purchasing decisions will increasingly be made on the strengths and weaknesses of manuals.

Imagine this scenario: a hardware-store owner is shopping for a computer. He's attracted to the Apple II because he's learned that the Apple can run software to write invoices. But lo and behold, the local computer store stocks five invoicing programs for the Apple—programs that just aren't all that different.

Which program does he buy? He looks at the documentation, and he buys the program that has the most attractive, readable, and understand-

About the Author

Dana Sohr is a freelance technical writer and editor. He writes a column on computers for a national trade magazine and is a consultant on office computers for the newspaper industry. His recent work includes a manual for LITMAS (a cross-indexing program for the Apple II) and one for Calc Result (a spreadsheet program for the Commodore 64).

Acknowledgment

This article was prepared as part of a research project done in conjunction with Ben Shneiderman of the University of Maryland Computer Science department. Sincere thanks go to Dr. Shneiderman for his advice and ingenuity.

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able manual.

Buyers are discriminating. In the future, when there will be more competing products from which to choose, buyers can afford to be even more discriminating. They will buy from anyone who can give them readable, usable manuals.

The same thinking also applies to computer-store owners. Why should store owners bother to sell a program with a shoddy manual when they can sell a competing program with a good manual? If they sell the first program, they know they will receive follow-up phone calls from frustrated customers and may even have to conduct in-store training sessions. But if they sell the competing program with the good manual, the store owners will spend much less time supporting the program; they'll receive fewer phone calls and answer fewer questions. For computer-store owners, it's more profitable to sell those programs backed by good manuals.

Good software manuals require an investment of time and money. Once that hurdle is crossed, producing a solid manual is a matter of knowing who the user is, how the user learns, what he needs to learn, and how to evaluate the finished product. This article offers advice to vendors and writers. It is designed to prevent the question, "How does this software work, anyway? I couldn't understand the manual."

A manual *transmits* information. Unfortunately, the transmission has to overcome some big obstacles before reaching its audience, the user. The biggest obstacle is the user himself.

Create the Right Tone

Many will agree that first impressions are lasting ones, and the user's first impressions of your manual are crucial. If your manual is sloppily packaged and typographically ugly, or if it appears to be a well-packaged piece of technical drudgery, you are working at a serious disadvantage. You aren't trusted, you aren't liked, and any information you attempt to transmit will be distorted. Create the right tone, and what you transmit will be received.

Define Your Audience

To create the right tone, think of the user, then tell that user what he wants to hear. If the program handles accounts receivable, tell the user how quickly and accurately he can send out his bills. Then tell him how easy the program is to learn and use. If the program does payroll, tell the user how quickly and accurately he can print checks. Then tell him how easy the program is to learn and use.

Entice and assuage the user by giving him what he wants, then go on with the business of listing necessary equipment, describing specific features, and detailing how to go about using the program.

Your target audience will determine whether you transmit information at a breakneck speed or parcel it in doses. Study your intended users, and ask yourself some questions. What does the program do? Does it compile BASIC code, or does it teach BASIC? Different programs mean different users. The user of the first program, who is already writing his own code, understands something about programming. The user of the second program, who would like to write his own code, understands far less.

A manual for the experienced user should transmit information at a faster pace than does the manual for the novice. (For example, the first manual should not stop along the way to explain variable arrays; the second manual should.) By making educated guesses about the intended users of a program, you can determine what information the manual should transmit, and at what pace it should be transmitted.

In tutorials for novices, tone and pacing are crucial. Novices are bound to be shy about using a computer, and in some cases they will be terrified. Remember, many computer users today do not voluntarily decide to work with a computer; the decision is made for them by their managers. A manual for these novices must do several things. It must soothe fears ("You can't hurt the computer, and the computer can't hurt you"); it must motivate ("The computer does the mindless tasks you always hated to do"). Only after you've created the

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right tone should your manual go on to provide well-paced, step-by-step knowledge.

Often you can't classify the typical user of a program. For example, both novices and seasoned computer users buy word-processing programs. In this case your word-processor manual should cater to the novice. The manual will not neglect the experienced user because all the information is provided, just at a slow pace. The experienced user knows how to use the keyboard, how to control the cursor, and how to protect disks; he can bypass such instructions and get to information he hasn't encountered before. Rather than resent the manual for slowing him down slightly, he'll probably wish that when he was a computer novice such a manual was the rule, not the exception.

Now that you know who the user is, how to create the right tone, and how to pace the manual, think about how to transmit information in a way that makes learning easy. After all, the user might be receptive to new information, but the information serves no purpose unless he can understand and recall it. Learning hinges on the way information is organized and the way it's presented.

Organize by Tasks

No matter who the intended user is, a manual should be *task-oriented*—organized according to the tasks the program performs.

Although software manuals are, as a group, moving toward this orientation, a large number retain a more primitive organization. Many manuals are option-oriented; they begin with a section on the program's first menu option, then proceed to a section on menu option 2, and so on. That's fine—unless the user cannot perform the options in numerical order.

Consider chapter 1 of a certain bookkeeping-program manual. This chapter describes how to prepare invoices because "Invoices" is listed as menu option 1. In chapter 13, the user is instructed on recording customers' names and addresses because "Customers" is listed as menu option 13. Unfortunately, until the user records his customer information (chapter 13), the program won't let him prepare invoices (chapter 1). So the user must read all the way to chapter 13 before actually doing work with the program. And after getting to chapter 13 and recording customers, the user must then try to figure out what to do next. Can he now go back to chapter 1 and prepare some invoices, or does he have to do something else first? The manual doesn't help him at all.

Learning hinges on two basic factors: the organization and presentation of information.

An option-oriented manual doesn't synthesize information; it dumps it in the quickest (and cheapest) way possible. The user must read every chapter at one sitting, then try to arrange the information into some sort of logical order.

This scheme of manual organization makes great sense to the programmer, who organizes a task by breaking it into discrete sections of code, but it makes no sense to the user, who needs to be told what tasks to do and when to do them. For example, a word-processor manual should not begin with instructions on creating disk files because the program can't be used that way. Instead, the manual should first tell the user about editing and formatting, then tell him how to save material.

Task-orientation is no great mystery. Before you begin writing your manual, analyze the various tasks the program performs, then describe those tasks in the order in which the user should perform them. Make sure that all information needed to do the tasks is provided and that extraneous information isn't included. Most users don't care how a program works; they just want to know how to use it.

Organizers

The manual shouldn't joggle the user with unexpected material because the user won't understand it fully. And if he doesn't understand it, he certainly won't be able to recall it.

To prepare the user for new information, include organizers in your text. The organizer, a very simple tool, can be a short introduction to a new section or chapter. An organizer for chapter 2 of a word-processor manual might look like this:

> *In chapter 1 you learned how to format and edit what you type. In this chapter you will learn how to save what you type. Saving text on the disk will create a "disk file." Think of a disk file just as you would think of a file in a file cabinet. You can look at a disk file at any time, just as you can look at a file in the file cabinet. You can also add things to the disk file, change the file, or throw the file away . . .*

With this organizer in mind, the user can easily understand the purposes of the SAVE, REPLACE, and ERASE commands.

As the example shows, the organizers should look backward and forward at the same time. They should tell the user where he's been, where he is, and where he's going. A new computer program is a strange land in which the user can easily get lost. If the manual provides organizers, the user is always on solid, familiar ground. If organizers aren't provided, the user wanders aimlessly. He's never certain where he is, and the little that he learns is gained by trial and error.

Move from the Whole to the Parts

Organizers alone don't ensure that the user will understand and recall new information. The manual should also move from the whole to the parts. At the same time, new information should be linked to knowledge the user already has.

Consider a wholesaler who buys an accounts receivable program. Like most software, this program was purchased because it makes a particular task easier to do; the wholesaler already knows a lot about that task before he lays his hands on the manual. He already knows, for instance, how to prepare an invoice. He

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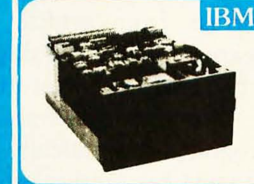
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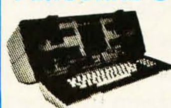
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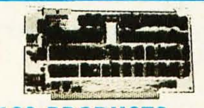
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knows that the invoice should include the customer's name and address, inventory codes, prices, and so forth. He also knows that, according to his usual method, after preparing an invoice he must manually adjust customer accounts, tax accounts, salesman accounts, and so on.

However, while he knows how to prepare an invoice by hand, his new program does it differently. And the manual can use these differences to its own advantage.

People learn partly by contrast; new information isn't understood until a person compares it to a pattern created by older knowledge. For example, the statement "red is a bright color" can be understood only by mentally comparing red to other colors. Likewise, the wholesaler won't understand his accounts receivable program until he compares it to what he already knows. The manual should make that connection for him. It should briefly summarize how invoices are prepared by hand, then summarize how the *program* prepares invoices. This links new information to old knowledge, creating a clear contrast from which the wholesaler learns. "In the old days," he thinks, "I had to do all this stuff by hand. Now, after I prepare an invoice, the program automatically adjusts my customer, tax, and salesman accounts."

By starting at a simple whole and by linking new information to old knowledge, the manual gives the user his bearings. Now it can safely move on to the separate parts of the task and present step-by-step detail on preparing invoices.

Repeat, Repeat

Sure, the user is intelligent; he bought your software, didn't he? But don't assume that he will instantly grasp important points. You have to repeat those points several times, then mention them once more in summary passages.

I'm not advocating that manuals be written for the addled. What I am arguing is that learning a new program is not unlike being in third grade and learning multiplication. Remember third grade? How many hot afternoons did you spend at the flash cards until you could remember that 9 times 9 equals 81?

Because manuals should move from simple to complex information, it's critical that you make sure the user is with you every step of the way. This means that every important piece of information should be highlighted and dwelled upon, then drilled into the user's head. You can do this subtly, by providing several examples of a feature new to the user. Or you can do it directly, by repeating a definition. In a word-processor manual, for example, the user could be told several times the purpose of a command: "Remember, when you use the REPLACE command, the file you were working on *replaces* the old version of the file." Using this direct repetition, you run the risk of irritating those users who understood the REPLACE command immediately. But if you skim over important points, you run the risk of frustrating many users.

By orienting the manual around the tasks that must be performed, by providing organizers, by linking new information to old knowledge, and by repeating important information, you take a long step toward ensuring that the user can understand and recall new information. But that's only half the story. You also must present information in a way that helps users learn.

Write Actively and Logically

When you prepare a software manual, you serve as a teacher. Unfortunately, you can't communicate verbally with the user. You can't shout and wave your arms and prod the user awake. You don't even know when the user's attention is lagging. However, if you write to engage the user at all times, presenting your material in a warm and lively style, you stand a good chance of communicating effectively. Dry, passive, turgid writing is not only boring, it hinders communication.

Use active verbs. A passive sentence such as, "The program was bought by Mary," takes about 25 percent longer to comprehend than the

sentence, "Mary bought the program." Moreover, the second sentence, because it is more vigorous than the first, is easier to remember.

Arrange instructions in correct sequence because that's how the user should perform the instructions. If you give the instruction, "press the 'x' key while holding down the Shift key," the user will probably press the 'x' key, then the Shift key, and discover that nothing happens. Change the instruction to, "hold down the Shift key, then press the 'x' key."

Illogical instructions disrupt and sometimes destroy your message. You should also avoid pointless redundancy (e.g., "a total of four disks"), inconsistency (a command is first "SAVE" then "Save"), pretentiousness (using "determine" where "check" would do), and vagueness ("enter the file name").

Write Relevantly and Simply

Make your writing more personal, more relevant to the user. Use the pronoun "you," not "we," as the former is more relevant to the user. Use the present tense; again, it is more relevant to the user.

Make the manual *human*. Use humor. Use familiar, everyday examples and analogies. Use hypothetical characters. Talk *to* your reader, don't just write *at* him.

Such techniques are, unfortunately, considered to be the tools of novelists alone. What the manual writer often forgets is that he, too, must serve his audience. He must instruct the user, but that's impossible when the user is bored and frustrated. Literary techniques applied with discretion keep the user interested and receptive.

Write as simply as you can. Avoid abstract nouns and verbs (e.g., concept, conceptualize). Abstractions do nothing but disrupt your efforts to teach the user. Above all, don't use jargon unless it's necessary and unless you're willing to define it the first few times you use it.

Use artwork wherever possible. Photographs and illustrations break up large bodies of type, attract the user's attention, and make information more relevant. Instead of simply describing how to load disks, include an illustration. Rather than just describing an important screen image, include a photograph.

Evaluate with the Eyes of a User

The evaluation is the last line of defense against errors, but too often vendors and writers ignore it (judging by their final products).

The evaluation doesn't have to cost a lot of money, and what money is spent comes back in the form of customer loyalty, goodwill, and sales. During the evaluation, you should identify and correct the manual's shortcomings; errors should be removed and omissions filled in. A critical evaluation produces a well-written, truly instructive manual that will make friends of users and computer-store owners alike.

You can evaluate the final draft of a software manual in various ways. Some methods cost more than others, and some are more effective than others, but no single method is sufficient. A thorough evaluation will incorporate two or more of the following methods:

Editing: Hire a professional editor on a temporary basis, preferably an editor experienced with instructional materials. An experienced editor can read the manual as the user would, and he can correct writing deficiencies.

Checklist: The checklist, a very simple method of evaluation, sets standards for what the manual should provide. Here's an example of a much simplified checklist:

- Does the manual include (1) a table of contents, (2) an index, (3) introductory and summary material for each section and chapter, (4) a tutorial section in which the user gains hands-on experience with the program's functions, and (5) a quick-reference section in which the user can find information quickly and easily?
- Is the manual task-oriented?
- Does the manual move from the whole (a nontechnical overview) to

the parts (step-by-step knowledge)?

- Does the manual tell the user how to recover from errors, and are all error messages listed and explained in a section where the user can find them easily?
- Do section headings give a good idea of what the sections contain?

To devise a thorough checklist, examine existing manuals. What mistakes did you make in the past? What did you omit? Why did users complain?

Devising a checklist takes time, care, and effort. Fortunately, it can be used to evaluate future manuals, too. But the checklist alone is not a thorough method of evaluation. It uncovers mechanical errors but cannot uncover missing or ambiguously worded instructions.

Self-Review: Self-review, like the checklist, is a simple method of evaluation. The manual writer tests to see if he can use the program based only on the manual's instructions. In the process he typically uncovers missing or ambiguous instructions, incomplete descriptions, misspellings, and grammatical errors.

Self-review should be used for every manual but not as the sole method of evaluation. The writer, if he has any ego at all, isn't objective about his writing; he likes what he has written. Further, he already knows how to use the program, and during the self-review he may unconsciously supply information that is missing from the manual.

Programmer Review: Have the programmer review the manual. The programmer checks to see that the manual has covered all the program's functions and that it has covered them correctly. Unfortunately, while the programmer is the person best qualified to evaluate the technical accuracy of the manual, he will probably be of less help in evaluating the manual's organization and presentation.

User Walk-through: Select potential users of the program, hand them the manual, and see how quickly they learn the program. (Select worst-case users—people who have no computer experience.) Are they confused and frustrated by certain sections of the manual? Do they have trouble finding information they need? Revise the sections where users run into trouble. Include more introductory and summary material, provide more examples; provide whatever the users believe is lacking. Then repeat the process with another group.

Users, after reading the manual, can be formally tested on their proficiency with the program. Can they perform all of the program's functions? How long does it take them? If a large percentage can't perform a certain function, revise the sections where that function is covered.

Users will often respond in mysterious ways to instructions that seemed perfectly clear to the writer. Those instructions can easily be revised. Users also uncover missing instructions and incomplete descriptions better than the writer or programmer can.

Field Test: If you're willing to spend some time and money, conduct a formal field test of both the program and the manual. Install the program at several sites, provide drafts of the manual, and then wait for the phone to ring. Are the test users calling you day and night? Can they understand the manual? Can they use the program? It costs less to answer these questions now, when only a few people are trying to use the program, than when 1000 buyers are calling in for help.

After two weeks, ask the users for comments and suggestions. Accept criticism, then use it to improve the manual. As in the user-walk-through method described above, test the users for specific knowledge, then revise the sections that don't seem to be communicating effectively.

Conclusions

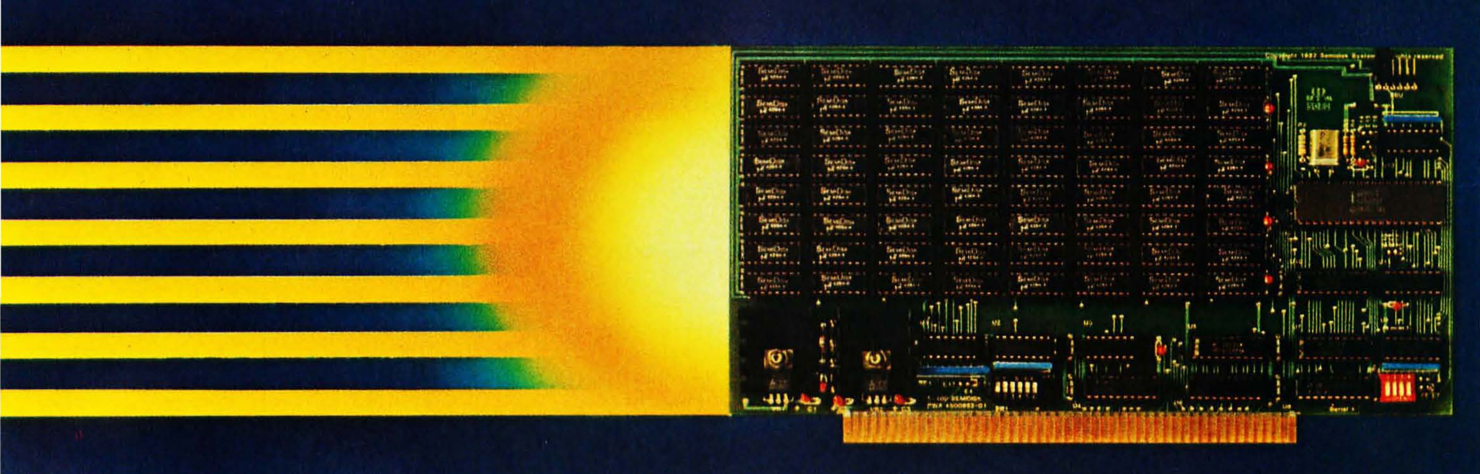
Buyers want and expect good manuals, and they will buy from anyone who can provide them. Thus, the poor quality of many of today's manuals offers a tremendous opportunity to enterprising vendors. Those who make a serious effort to produce well-written, instructive manuals will have a big advantage over their competitors; those who do not make the effort will eventually fall by the wayside.

In all things—preparation, organization, presentation, and evaluation—all decisions hinge on the user—who he is, what he knows, and how he learns. If you constantly keep the user in mind, you're on your way to producing a readable, usable software manual. ■

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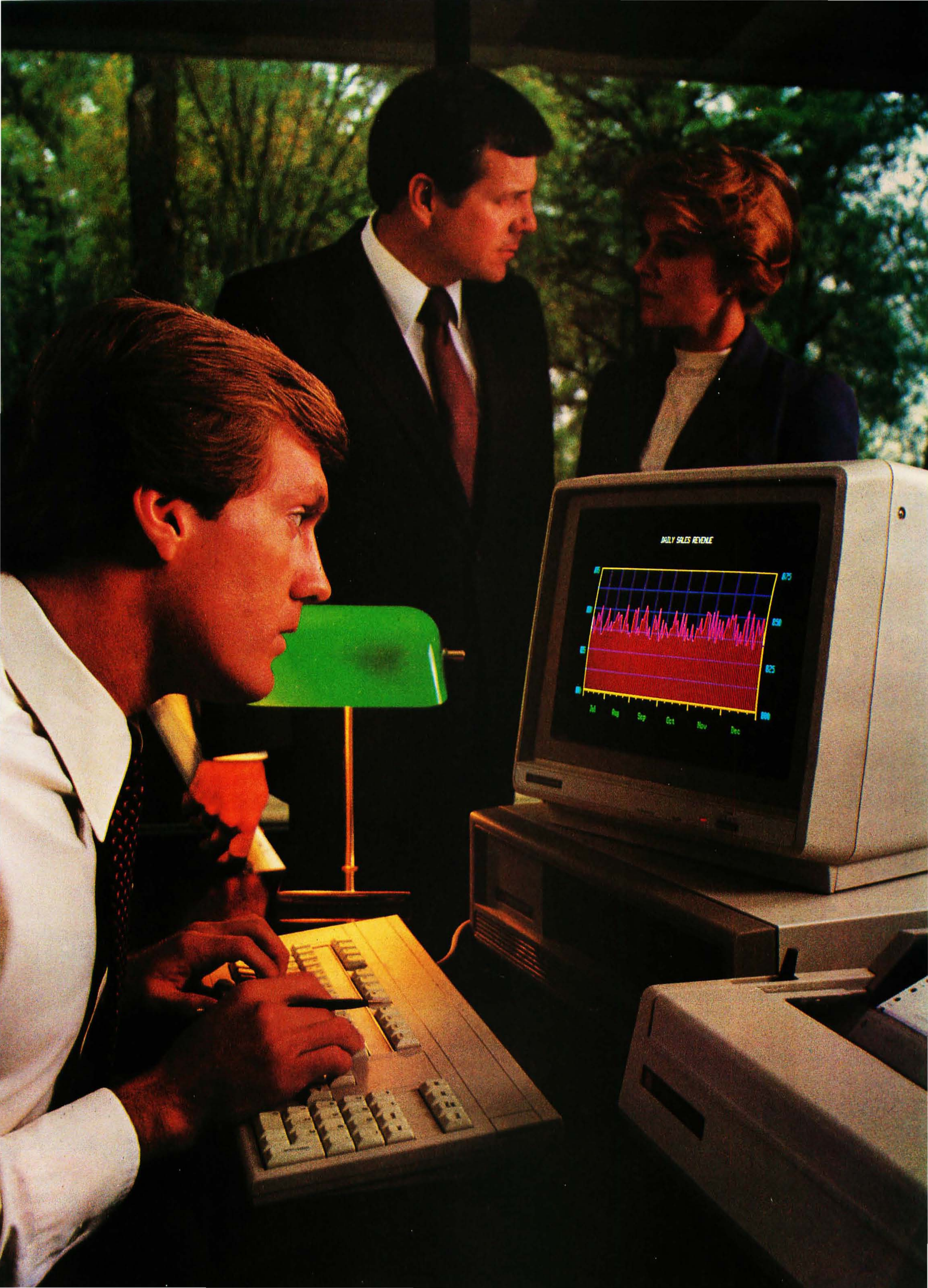
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Ulterior Motives, Lobo, Buying Your First Computer, JRT Update

A first look at Modula-2 excites our resident critic.

Jerry Pournelle
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Let me begin with a confession: while I have a lot of fun with this column, I have an ulterior motive. True, this is the *User's Column*, and it will always be primarily for the benefit of computer users rather than hackers.

(As did many computer terms, "hacker" seems to have originated at MIT. The original German/Yiddish expression referred to someone so inept as to make furniture with an axe, but somehow the meaning has been twisted so that it now generally connotes someone obsessed with programming and computers but possessing a fair degree of skill and competence.)

My ulterior motive is to seduce my readers into becoming interested in what's happening in their machines, and in the computing world generally. For example, you may never learn a programming language, but the availability of good programming languages vitally affects you as a computer user; if hackers can't get powerful, well-documented, and highly portable languages, programs are going to cost far too much. In the worst case, we might drift back toward the "high priest" syndrome that dominated computers back in the days of clean rooms and white coats.

So: for those who've written to ask, that's why I am and remain interested in languages for microcomputers. On which subject . . .

The big news is that Modula-2 runs on the Sage II computer. Modula-2 is the new language by Niklaus Wirth, the inventor of Pascal. If I'd known about it, I might not have started the Pascal Prime Project; Modula-2 is supposed to have most of the fixes we've all wanted for Pascal, plus a lot of other features.

(The Pascal Prime Project is a meeting of publishers of Pascal implementations for microcomputers; the meeting will, we hope, establish some standards for Pascal extensions.)

Pascal was intended as a teaching language, to be "compiled" on paper by instructors. A lot of people liked it, and transformed it into a "real" programming language. It was limited, particularly in text-handling and I/O (input/output) features, but it attracted a lot of adherents.

Modula-2 (short for modular language) was intended from the beginning as a full-fledged language. It was produced by Wirth after nine years' study of the problems of Pascal, including a year's sabbatical working with Mesa, the "Pascal-like" Xerox internal-development language. Modula-2 is supposed to have all of Pascal's desirable features, plus corrections for all its drawbacks.

We'll see. I only just have it running, so I can hardly claim to be an expert. On the other hand, I've liked everything I've seen so far. Modula-2, as the name implies, is compiled in chunks; once a chunk is working, it can be put into a library, accessible to any program that wants it. No more endless compile operations!

In particular, all Modula-2 I/O is "magic"; each implementation comes with a standard library of I/O routines that look a lot like an operating system. Programmers simply import them from their black box, and once they're available, invoke them as standard procedures. For example, you could have a module of CP/M I/O routines. It

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would contain error-handling routines—including the infamous BDOS errors, but supplemented with real information as to what has happened and what you should do now.

Note that the I/O routines are not part of the compiler. On the other hand, once they've been perfected and tested, they need never be compiled again; in fact, the compiler will complain if you try to compile (or link in) more than one version of the routines. The bottom line is that a good Modula-2 package should make I/O at least as convenient as CP/M or the better grades of BASIC—with plenty of capability for improvement if wanted.

I don't really know what that means in terms of compiler writing problems, but I don't have to care. From the user's point of view, many of Pascal's I/O problems vanish, and that's what's important.

The only microcomputer implementation of Modula-2 that I know of comes from Volition Systems, a group of computer hackers from the San Diego area. Its Modula-2 comes with a thick stack of documents, including Wirth's book *Programming in Modula-2*. Volition Systems claims that a good Pascal programmer can become proficient in Modula-2 within a week. I can't vouch for that, not having had a week at it yet. I can testify that the documents seem to be written in English, and I've had no problems with the (rather small) parts I've waded through.

Late addition: Logitec of Los Gatos, California, promises a Modula-2 native-code compiler for the 8086 computer before June 1983. At present, it runs on Niklaus Wirth's machine in Switzerland.

My initial reaction to both the language and Volition Systems' implementation is positive. A few of the language constructions seem a little odd, and I know I would not have done certain things quite the way Wirth did—but they do make sense; at least those I've encountered do. Unlike my first experiences with Pascal, I don't find myself continually wondering, "Why the daylight did he do *that*?"

As I said, we'll see. Just at the moment, the only thing we have here that can run Modula-2 is the Sage; that's not a problem, because the Sage works beautifully. By next month we'll have thrashed it about, and I'll be able to report benchmark times and things like that. Meanwhile, our love affair with the little Sage II continues; if you like UCSD Pascal and the "Scud" (UCSD p-System) operating system, you'll love that machine.

Volition Systems' Modula-2 runs on virtually any machine that can run p-System Pascal; in particular, that includes the Apple II and III as well as the Sage.

More Good News

One of the best things that happened to microcomputers in 1982 was the pseudo disk: a system for fooling your computer into thinking that a bunch of memory is a disk drive. This really speeds up compilations, assemblies, and other tedious work.

I'm told it started in England under the name "Silicon Disk." My first experience was with the "Warp Drive" developed by G&G Engineering (San Leandro, California); this used the 8088 in a Compupro 816 dual-processor computer to turn superfluous ordinary memory into a pseudo disk. Later, that got modified into what is now called M-Drive, and I use it all the time.

Then came Semidisk—a board especially intended to be a pseudo drive; unlike the Compupro M-Drive that required a dual processor and a direct-memory-access disk controller, the Semidisk board would work with any S-100 system. (There are also versions for the IBM Personal Computer.) We installed it in our Compupro as the N-Drive, and I've happily used it ever since.

Comes now the *Compupro* M-Drive/H. This, too, is a half-megabyte pseudo-disk board that can be connected to any S-100 system. It's a little faster than the Semidisk, although you won't notice that unless you're using a superfast processor. M-Drive/H lists for about $100 less

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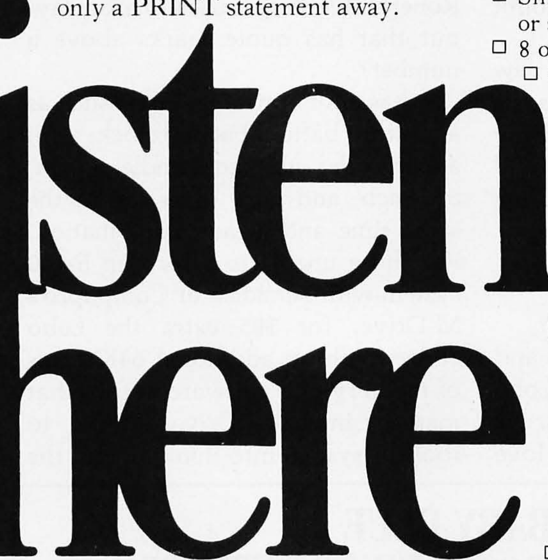
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than Semidisk; both are sold at discounts by various mail-order houses. *Neither is at all* difficult to install given familiarity with CP/M and the innards of your system. (If you don't know or care what a number in base 16 is, find someone who does before trying it.)

You can put in more than one M-Drive/H if you need a pseudo disk larger than 500K bytes; or you can get a full-megabyte Semidisk board for $2995. I've never needed more than half a megabyte, so I've tried neither method, but I've no doubt both would work.

There seem to be as many new sources of pseudo-disk boards as there are manufacturers of memory boards, so I expect competition will drive the price down a lot during 1983.

Lobo Howls Again

Barry Workman of Workman and Associates has his new Lobo. Lobo calls it a Max-80. Barry calls his Ralph. As far as I can see, it was love at first sight.

The Lobo comes with a *completely* reprogrammable keyboard and extensive documents; there's even a disk source for both the keyboard and the screen codes. Thus, if you want the key that most people believe is the "E" to be the Return key, you can set things up that way. If I ever get one, I probably will change the key tops; I can't say I care for the Teletype keyboard layout Lobo has chosen (although my late mad friend would have liked it, and my colleague Robert Silverberg is used to a key layout that has quote marks above a number) . . .

It has a lot of neat features, such as a built-in, battery backup clock; also, a controller able to handle 8-inch, 5¼-inch, and hard disks, all at the same time and in any combination. For those unable to afford an S-100 system with Semidisk or Compupro's M-Drive, for $95 extra the Lobo comes with an additional 64K bytes of memory plus software to turn that memory into an I-Drive—that is, to fool the system into thinking that the extra memory is a small, but very fast, disk.

The Lobo processor is a 5-MHz Z80A, making it faster than Alex's 4-MHz CCS S-100 machine, and nearly as fast as Zeke II, my Compupro 6-MHz Z80B. Indeed, the Lobo runs as fast as the 8085 in my Compupro 816 dual-processor machine, since we had to slow that down to 5 MHz to accommodate Jim Hudson's 8087 math chip.

All in all, at $820 ($915 with the extra 64K-byte memory) including CP/M 2.2, the Lobo is a strong candidate to be one's first machine. If you get one, consider getting the Zenith 12-inch Green Screen, which I've seen at Priority One for as low as $89.50. I think it's slightly better than the Amdek that Lobo sells, and costs less. You'll also need disk drives; but I note that dual-drive 8-inch systems (single-sided) complete with case and power supply can be had for as low as $600, and are regularly for sale at considerably less than $1000.

There is this problem: Lobo does *not* furnish the source to the CBIOS (customized basic input/output system; the "hooks" by which your system talks to CP/M); and this means that you can't be *sure* that all disk systems will work properly with the Lobo. You can assume that all those Lobo sells will work, of course; but if you want to replace them, or you already have disks, you take your chances.

I don't understand why Lobo doesn't give you the CBIOS source. It's not as if it were a valuable secret, and I must have a score of letters detailing awful problems that would never have arisen if my correspondents only had the source to the CBIOS. With all-in-one package systems like the Osborne, there's not such a strong need for the CBIOS source. After all, Osborne has a big network of dealers to provide support for purchasers who get in trouble, and you're not supposed to be adding non-Osborne stuff to the machine anyway. However, systems like the Lobo are useful in large part because of their flexibility—but not having the CBIOS reduces that flexibility by a lot.

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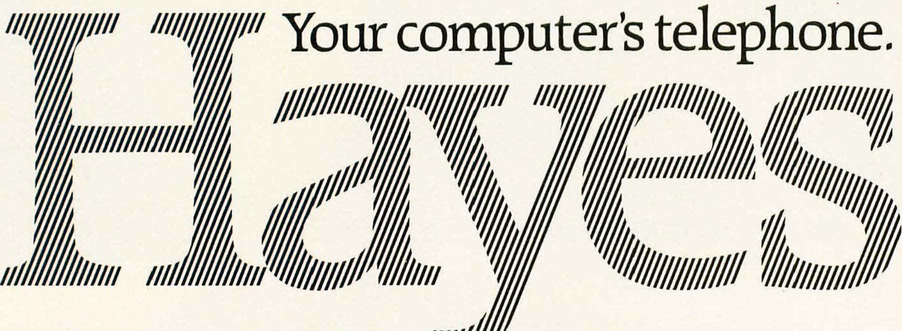
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Anyway, Barry Workman and my son Alex like their new Lobo. Me, I'll continue to reserve opinion until I've watched for a few months; but I'll admit that I'm impressed by what I've seen so far.

Things My Postman Brings Me

A lot of people seem to think I'm a last resort for advice. Sometimes I can help, but fair warning: I try to answer all my mail, but work here ebbs and flows, and when it's at flood tide it can take weeks to months for me to get at something. I apologize. I was brought up to believe one should promptly answer one's mail, and John Carr and I try; but some days the press is just too much, and letters get into places they shouldn't, from which moldering piles they surface only by accident.

I've recently received a stack of horror stories. One, from Professor R. W. Marks at Villanova, concludes:

> *The sum total of my experiences have led me to several rules for microcomputer buyers. (1) Will an abacus do? That is, will the grief you have to put up with be compensated by the advantages of a big machine rather than a toy? (2) Don't be misled by the size of a company. As Lily Tomlin says, "We're the phone company. We don't care. We don't have to." XXX and YYY (two large mail-order dealers) don't care. They don't have to.*

[**Note:** I don't name the two firms, because I've had no bad experiences with the one, and no experience at all with the other. As a matter of policy, I insist on several instances before naming names. . . .J. E. P.]

> *(3) Unless you want to learn one hell of a lot about the S-100 bus and the BIOS and the other pieces of alphabet soup, buy a system already integrated, or pay someone to do the integration. I'm not very impressed with what Apple offers for the money, but the thing runs as soon as you plug it in. (4) Under no circumstances trust salesmen or manufacturers to tell you anything remotely close to the truth about a product before you buy it. You will get all the rude surprises only after you have paid for the thing . . .*
>
> *(5) Don't assume that expensive pieces will come with manuals.*

Dr. Marks describes one experience: he bought a T.E.I. mainframe from Jade. It arrived, and . . .

> *I discovered it had come without any documentation, missing the main fuse and fuse cap, and seriously dented in one corner. I immediately called Jade and was told (no joke) that it was supposed to come without documentation, fuse, or fuse cap, and they were sorry about the dent, but it wasn't a Jade item and they were not responsible . . .*

Eventually, through persistence, he got someone at Jade to admit that the box was supposed to have documents; and finally they arrived. (Dr. Marks found them "surprisingly good.")

The story goes on, but the point is made: in dealing with mail-order houses, bigger is not necessarily better; and you'd better be prepared to be patient. Perhaps then, one should go to a computer store? It's time to hear from another reader.

Larry Hansford, a systems consultant in New Carlisle, Ohio, says:

> *A typical scenario is a businessman who goes to the nearest computer store and tells the salesperson that he needs a computer for accounting and word processing. He walks out of the store with boxes in hand containing a computer, printer, software, supplies, and very little idea what to do with it.*
>
> *Some time later, I get a call from an irate businessman who feels he has been taken advantage of. Unfortunately, he probably has been! I have been less than impressed with the knowledge of the salespeople in most of the computer stores. Their goal is to get a commission, not to make a satisfied customer. Most are, however, near experts on computer games of any and all types.*
>
> *I appreciate the resulting business I get, but I resent having to clean up the mess. If they'd gotten competent advice in the first place, they'd have paid less and gotten more.*

Unfortunately, both my correspondents are right. Buying parts by mail order can, if you're not careful, bring you unrelieved grief; but going to the local computer store can be an even less satisfying (and more expensive!) experience. What, then, is one to do?

One solution is proposed by Erwin Strauss, sometimes known to science-

fiction conventions as the folksinger Filthy Pierre (indeed, his letter is signed Filthy). Strauss complains that my advice, namely that one should deal with systems-integration specialists who know what they're doing, is impractical. "Pournelle," he says, "gets special service because of his BYTE connections, and as for that nighttime visit by Tony Pietsch, that's like the *New York Times'* restaurant critic asking a top chef to whip up something and deliver it. For us mere mortals, it's more like getting a neurosurgeon to come over at midnight to put on a Band-Aid: if we succeed, we'll need scientific notation to figure the bill." He continues:

> *I have some advice that's more practical. First, choose a computer that's been widely promoted (preferably on TV) for at least a year. Jerry may dream about the day when makers "no longer use their customers as a quality-control department," but for now the best thing is to let those who always have to be first on the block be the guinea pigs. If there hasn't been a big stink about a heavily hyped machine after a year, it's probably not too bad. This rule also means there'll probably be a service shop near you that's seen a good number of broken computers come in over the counter, so they should be able to diagnose accurately, and fix quickly, the problems that are characteristic of your machine.*
>
> *Of course, this cuts the field down to names on the order of IBM or Apple or Radio Shack and such. I can already hear Jerry mooning over the features of his Godbout and Televideo and suchlike gear; but a novice has no business with that level of equipment.*

Strauss goes on at some length, ending by saying that if you have unlimited money ("as long as it stays within, say, four figures") you should pop for an IBM PC; otherwise, get a TRS-80 Model III. He's not so certain about the Apple II (despite its widespread publicity), and he hates the Apple III. He concludes, "Whatever the off-the-shelf system you get, you can be sure that it won't do everything you like, and it won't do much of what it does quite as handily as you'd like. But it will be serviceable, and at an affordable price, and with a minimum of start-up hassle."

That's one opinion. I have another.

How to Buy a Computer

First, regarding Strauss's comment that "a novice has no business with that level of equipment," I couldn't disagree more. True: I certainly wouldn't aim a novice user at one of Bill Godbout's newest state-of-the-art systems; but then neither would Dr. Godbout. Tony won't let me have some of the new stuff I own until he's thoroughly bashed it about and found its limits.

Buying by mail order can, if you're not careful, bring you unrelieved grief.

However: because a company is out at the frontiers of computer technology doesn't mean it can't and doesn't make good stuff for the ordinary user. Indeed, Compupro is an excellent example: here in this room I have three of its systems. One is Zeke II, the Z80 I'm writing this on now. The Z80 has been around so long that it's practically old hat; and Zeke II is utterly reliable, quiet, and operates nearly invisibly.

(True: we have customized the screen output and keyboard on Zeke II; but the system itself is very much standard from Compupro, and it works quite nicely with either the Televideo 950 or the Zenith Z-19 terminals.)

The second is an 8085/8088 dual-processor computer, as staid and stolid as you can get nowadays. When we first brought it up, Compupro was the only outfit that *had* a dual-processor machine, and I certainly wouldn't have recommended the system to a beginner; now it has become a standard, and consultants like Bill Grieb and Colin Mick recommend dual processors for vanilla systems.

Moreover, you can get a good S-100 system for at least no more than you'd pay for an IBM with comparable capabilities, and I for one prefer the more flexible system. My motto remains, "Iron is expensive, but silicon is cheap." With an S-100 system you can upgrade for less than with anything else I know of; and upgrades can be very significant.

I see many exciting new systems in development: 16-bit systems, even 32-bit systems, all upward-compatible with what I have at present. Right now all I have to do to make my 8085/8088 dual processor into a 68000 system is replace *one board*; all the memory, disk drives and controller, modem, I/O boards, and such like will work fine.

My third Compupro machine is utterly experimental, with a 12-MHz 8086 board. Now I certainly wouldn't recommend that for a novice; not this year, anyway. Next year, though, might be a different story.

Moreover, my experience with TRS-80 and Apple systems hasn't been as pleasant as Strauss implies yours will be. We hadn't had our Apple a month before it required major repairs; its switching power supply blew and took with it the motherboard and every card in the system. Then we had the experience of updating our DOS (disk operating system): more than $60 for a single ROM (read-only memory) chip and a disk. This wasn't to get a new DOS, you understand; it was merely to update what we had. Now, they tell me, Apple won't even let you off that easily. In the future it will cost a great deal more to upgrade an old Apple II.

In fairness, I have to say that Carl Helmers has had *five* Apples for years. All run UCSD Pascal. His total repair bills for all five machines sum to less than $500. Carl admits the machines are limited, but he has no complaint about their reliability.

What he calls reliable, though, is not my definition. I agree with Bill Godbout: "If the error rate is high enough to measure, it's too high." I've watched a lot of computer users shake cables, reboot disks, flick switches on and off, and in general put up with glitches that would have me on the phone to Tony Pietsch in seconds. I trust my *living* to these machines. I cannot and will not put up with "rather more or less . . ."

The Apple is great for Epyx's (marvelously fun) Crush, Crumble, and Chomp, but when I develop pro-

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Cylinders	306	480
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Performance Specifications		
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Access Time		
Average Latency	8.33 milliseconds ± 1%	
Seek Time		
Track-to-Track	3 milliseconds	3 milliseconds
Average	85 milliseconds	120 milliseconds
Maximum	205 milliseconds	310 milliseconds
Settling Time	15 milliseconds	
Physical Dimensions		
Height	5.3″	5.3″
Width	12.1″	12.1″
Depth	16.5″	16.5″
Environmental Specifications		
Operating Temperature	40°F to 95°F / 4.4°C to 35°C	
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grams in UCSD Pascal or Modula-2, I'll use the Sage, and I won't regret the extra $1500 it costs.

As to our TRS-80 Model I, we trashed that sucker long ago. It was always unreliable, and repeated trips to the local Radio Shack outlet didn't help. The problem was that Tandy cut corners; I have a letter from a Tandy official referring to "the realities of the mass market." If you're selling 100,000 machines, saving five dollars a unit can be significant—both in profits to the maker and misery to the user. Our system internally generated so much radio noise that anything additional—even an airplane using Doppler radar!—could cause it to spontaneously reset.

We got the TRS-80 for the boys, but they were never happy with it. When they tried to use it, they might or might not be able to boot the system disk on the first try. There was always doubt as to whether they'd be able to save programs—or even save text they'd written. It was clearly an undesirable situation for young people learning to use and like computers, and eventually I got rid of it.

Again, in fairness, I understand that a lot of people are happy with the new computers Tandy puts out. My point is that advertising budgets don't have that strong a correlation with system utility and reliability. Just because a system is advertised on national TV doesn't make it a good buy any more than "as advertised on NBC" is a guarantee that your new car won't be a lemon.

Unfortunately, computer stores aren't the answer either. Example. I acquired a well-cared-for, second-hand Apple II from Bjo Trimble, the *Star Trek* lady. It was an older machine.

I knew nothing about Apple computers. The boys pointed out that we had a bale of software, mostly Epyx games, that wouldn't run with the disk operating system that came with our Apple. They'd looked over the games and very much liked them, and birthdays were coming up . . .

I could, I suppose, have studied up on Apples; but there's a lot to do here, and it wasn't convenient just then, so instead I packed the whole mess up and went out to Compuplus. After all, it specializes in Apples now, and I've been doing business with this outfit for more than five years, going back to the time when it was Computer Components and sold surplus equipment.

I arrived. Waited patiently. Got a salesman. Explained that I had an old Apple II, didn't know what boards were in it, and was interested in how to upgrade it.

The result could have been drawn up as a *Doonesbury* cartoon. The salesman cut loose with a string of jargon that certainly made no sense to me—and which I suspect couldn't have made sense to anyone else. He touted some games programs. I explained that I had plenty of games programs. He mentioned printers. I told him I had a printer.

I began to get the brush-off. Clearly, the commissions on bells and whistles for the Apple aren't worth a salesman's time; not that it mattered, because it also became clear that the

salesman didn't even know what was available. He never mentioned any of the stuff I'd come prepared to talk about, like Pascal, or a Microsoft Softcard. Fortunately the cashier was well informed and took the trouble to give me some advice; without her, the trip would have been an utter waste of time.

Even so, I left thinking about a letter I got a year or so ago. It said, "Some day the salespeople in computer stores will be able to recognize a customer when they see one. Then maybe they can learn what to do when they find one . . ."

Some computer stores are excellent. Many more are not. Unfortunately, those who can tell the difference aren't the customers with problems; it's precisely those who need help the most who can't tell whether the help they're getting is of any use.

So What Do You Do?

First, as I've said before: systems-integration consultants will earn their fees. True, Tony Pietsch isn't out looking for that kind of work now—but he was when I first met him. Filthy Pierre seems to have forgotten that when I met Tony he was a graduate student, and I was a science-fiction writer. This column grew out of my experiences, and, yes, I know I'm likely to get better than average treatment from people who know who I am now; but it wasn't always that way.

How do you find good systems consultants? How do you find any other professional help? The same principles apply. People who know what they're doing leave a trail of satisfied customers behind them. The really good ones don't hesitate to give references: their previous customers are their best salespeople.

Second, I do agree with Strauss on one point: unless you know what you're doing, don't go buy something brand new, particularly not from an outfit you never heard of. Wait for evaluations. Plenty of honest reviewers are in this field. Read what they have to say; and if all the reviewers ignore a system, ask yourself why. It may be we know something. Most of us would rather write an enthusiastic rave than a negative review. I know I would.

Third, ask yourself what you really want. Most of the horror stories I hear come from readers who tried buying their systems a piece at a time at sale prices. You certainly can save some money that way; but even if you're pretty sharp, you'll pay with your time. Take Barry Workman's Lobo system as an example: he bought his disk drives on sale from Priority One. The Lobo worked fine first thing out of the box when connected to my Compupro drives; but it took a couple of days fooling with configuration jumpers to get it working with Barry's new Siemens drives. If he hadn't been here, with access to Priority One's helpful salespeople like Keith Burgess and able to call Nor Singh, it might have taken a lot longer.

Unless you know what you're doing, deal with people who do; don't try to outsmart the system.

And that, I think, is the real bottom line: unless you know what you're doing, deal with people who do; which is to say, don't try to outsmart the system. If people who seem to know about these small machines try to tell you that we haven't yet got to where a naive user can put together a business-quality computer complete with software for less than a couple of thousand dollars, perhaps you ought to listen.

I don't know any magic way to get a system dependable enough to bet your livelihood on—serviceable, convenient, complete with software—for so-called home computer prices. I do see a lot of computers, and I know what I'd buy as of this afternoon; but that's a different thing.

When Roland Green, the Chicago author who worked with me on my new book, *Janissaries II: Clan and Crown*, wanted advice on a first system, I told him to look at the Osborne. It's not an optimum system, but I don't know a better beginner's package complete with software for a price Roland could afford.

When I went looking for a replacement for Ezekial, my dormant friend who happened to be a Cromemco Z-2, I did have an advantage the casual buyer doesn't have: I knew most of the major software developers, as well as a number of successful systems consultants. It seemed to me that people whose businesses depended on reliable equipment might have strong opinions on what was best; so I asked them what they used. When many more than half told me they had Compupro systems, it was enough for me, especially when I found that Tony had come to the same conclusion by studying the system specs; so that's what I bought. We sent in an order for the whole package direct to Compupro; and I haven't been disappointed.

When I go shopping again, I'll do the same thing; somehow I have more faith in the judgment of people like Richard Frank of Sorcim and Mike Lehman of Digital Research than in TV advertisements. But that, I hasten to say, is my view.

JRT Pascal, Revisited

A few issues ago I mentioned that when my son Alex finished his Pascal Tutorial Package for the Pascal/M and Pascal/MT+ compilers, he intended to work one up using the $29.95 JRT Pascal compiler.

I was premature in that statement.

Alex, it seems, has a wild talent: he carries a Murphy field about with him. Whatever Alex works with, it is very literally true that if something can go wrong, it will. He also likes to work things to their limits.

Example: we were overhauling my Minimum Data Base for Barry Workman, and Alex found bugs and failure modes that must have been in there for *years* without my noticing them. When I fixed those, *he* found others.

Another example: when trying deliberately to create a run-time error to use as an example for the Pascal Introduction, he found that Pascal/M will cheerfully allow you to divide by 0. Not only does it not report an error, but it thinks that 3/0 =

Text continued on page 314

Listing 1: *Pascal/M compilation of the Silly program.*

```
prun pascal n:silly.pas
  Source file name, options: N:SILLY.PAS,
  2. S#1 P#1      SILLY     levl     (10234 bytes)
            writeln(foo \ ); (* note undeclared variable *)
Line 5, Error #104 <sp> =continue, <cr> =quit?

            writeln(foo) \ ; (* note undeclared variable *)
Line 5, Error #116 <sp> =continue, <cr> =quit?

  104: Undeclared identifier
  116: Error in type of standard procedure parameter

    1 Errors,      7 Lines,      10100 bytes not used.      (ver 4.02)
```

Listing 2: *Pascal/MT+ compilation of the Silly program.*

```
mtplus n:silly.pas
Pascal/MT +                              Release 5.5
© 1981 MT MicroSYSTEMS, Inc.

CP/M-80 version

Source lines:                         7
Symbol Table Initialization
Available Memory:                     19933
User Table Space:                     15937
V5.5 Phase 1

Remaining Memory:                     15975
V5.5 Phase 2
SILLY

Error # 104 at line 5
Last ID: FOO

Type <space> or ^C

Lines :       7
Errors:       1
Code :      137
Data  :       0
Pascal/MT + 5.5 Compilation Complete
```

0.0E−65, rather the opposite of what you'd expect infinity to look like. (Pascal/MT+ allows the division, but reports an error; it sets 3/0 equal to a very large number, which is more reasonable.)

Something like that happened in analyzing JRT Pascal. It seems there are bugs in the compiler. Not terribly serious bugs; indeed, we found nearly as bad in Digital Research's Pascal/MT+ and Sorcim's Pascal/M. There's a difference, though. Whereas Pascal/M and Pascal/MT+ *try* to be standard Pascal, with nonstandard extensions, the JRT Pascal compiler doesn't. JRT is intentionally a nonportable dialect, and programs written in JRT Pascal haven't a chance of running under *any* other Pascal compiler; worse, programs that will compile in standard Pascal blow JRT Pascal sky-high.

Worse yet, though, is the error handling. Pascal was designed as a teaching language, and it has a standard set of error messages. They are numbered and have a standard format, and experienced Pascal programmers know most of them by heart. For example:

```
Program Badhello (Output);
 BEGIN
  writeln('Hello, world.');
  writeln('Foo')   (* note missing ; *)
  writeln('Hello again.');
 END {badhello}.
```

obviously isn't going to compile. Pascal/M and MT+ give you a standard message:

Error 6, Illegal symbol (possibly missing ; on line above)

which is probably the most common error encountered in Pascal. That error is rendered somewhat differently by JRT Pascal:

---- Semicolon expected

This is reasonable, although it doesn't do much for teaching you what standard Pascal messages look like. However:

```
Program silly (output);
 BEGIN
  writeln('Hello, world.');
  writeln('Foo');
  writeln(foo); (* note undeclared
   variable*)
  writeln('Hello again.');
 END {silly}.
```

has far different results. The error messages generated by Pascal/M and and Pascal/MT+ are shown in listings 1 and 2. These are about what you should expect. JRT Pascal generates the stuff shown in listing 3. Note that the only reference to an undeclared variable will have scrolled off the screen (it happens *fast*, too), and that there is no reference to the actual problem in the symbol table. The whole thing is pretty intimidating to someone just learning Pascal.

Pascal/M and Pascal/MT+ will show you where the error took place and offer you an opportunity to continue. JRT Pascal doesn't print the line, doesn't continue, and doesn't really identify the problem.

There has been a great debate in *Dr. Dobb's Journal* about JRT Pascal, with one reviewer contending that the language has its uses. He says it's a good production language for writing business programs and is certainly worth $29.95. Another reviewer says it isn't acceptable at any price. I'm not going to get involved in that argument. I do say that it is *not* a language for beginners. It has funny bugs and gives confusing error messages.

Beginners don't have enough experience to know whether their problems are caused by flaws in the compiler or in their program. Add error messages not related in any obvious way to the error—there are lots more that I haven't room to show—and you have a situation tailor-made for undermining the student's self-confidence. Thus, Alex has decided against writing a version of his introductory package for the JRT compiler.

Those who know Pascal might find JRT Pascal useful; I'm told by experienced programmers that you can, if you're clever, program around its bugs. However, beginners should stay away from it, and anyone dis-

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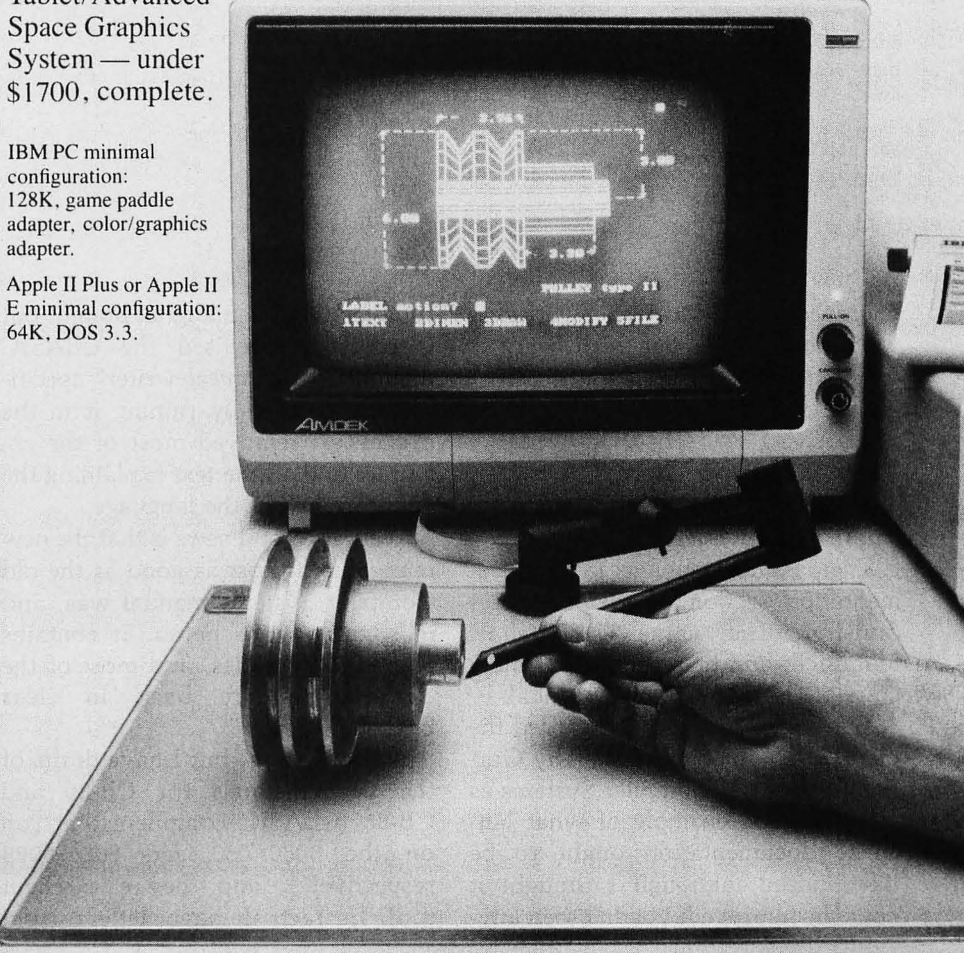
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Listing 3: *JRT Pascal error message for the Silly program.*

```
B>jrtpas2 silly

JRT Pascal      ver 2.0

Copyright 1982 JRT Systems

0000   0001:    Program silly (output);
0006   0002:              BEGIN
001B   0003:                        writeln('Hello, world.');
0026   0004:                        writeln('Foo');

%Warning: Invalid dynamic storage address—possibly due to invalid variable or data type
declaration.

                    exproc name    addr    use cnt    time    stat
                     PASCAL1       C8B6    0000       0004    30
                     LEX           41EB    0000       008F    74
                     PASCAL4       9FB2    0000       008B    30
                     ADDMAIN       431E    0000       0000    74
                     BLOCK         47D5    0001       0023    F4
                     FIND          59E8    0000       0089    74
                     PASCAL2       0001    0000       0000    00
                     PASCAL3       A1CB    0001       0078    B0
                     EXPR          5D5A    0001       0085    F4
                     UPDATE        78AD    0000       0000    74
                   + GEN           7AC6    0001       0090    F4
                     FLDLST        0001    0000       0000    00
                     PARMREF       7F08    0000       0000    74
                     UPPER32       8344    0000       0003    74
                     TEST          8367    0000       0000    74
                     LEX2          83A8    0000       008E    74
                     BIT6          85F0    0000       0088    74

addr  :7CA6  prog   :3F70  size   :4872
base  :87E2  cur    :8F43  tos    :8F66
low   :9ED2  compr  :0000  purge  :0000

@:TEMP2
%Error: Array index too small
```

couraged from Pascal by experiences with the JRT compiler might want to try something more standard before giving up.

They're Getting There

There's good news and bad news from Digital Research.

There's a new manager in the documentation section of the languages division. His name is Michael Franusich, and he recently sent me a copy of the new CBASIC manual.

You may recall that I regarded the old CBASIC manual written by Gordon Eubanks at Compiler Systems as a really good example of what language documentation ought to be like; indeed, although I thought it could be improved, I hadn't seen anything better. Then Digital bought out Gordon and revised the CBASIC manual to "technical writer" specifications, practically ruining it in the process. It removed most of the examples and all the text explaining the "philosophy" of the language.

Well, the good news is that the new manual is at least as good as the old Compiler Systems manual was, and in some ways is better. It contains plenty of examples, and most of the explanations are back in clear English.

Not only that, but I have drafts of the new manuals for CB-80 and CB-86 (CBASIC compilers that run on the 8080/Z80 and 8086/8088 respectively), and they're excellent too! In fact, I have letters from Digital Research people claiming that it has been my constant hammering that caused the reforms there. I'm not sure I fully believe that, but it's nice to think I had a positive influence.

In any event, I think we can look forward to really significant improvements in Digital Research's documentation.

That's the good news.

Alas, Poor SPP

The bad news is that Digital Research put out the new Pascal/MT+86 Reference Manual, and the manual for the MT+86 Speed Programming Package, *before* Franusich joined the staff; and lordy does it show.

I'm a great fan of the Pascal/MT+ Speed Programming Package (SPP). That, you may recall, is a combination Pascal text editor, source-code formatter ("pretty printer"), and syntax checker that adds many of the best features of UCSD Pascal to the CP/M Pascal/MT+ compiler. It became even more important for Pascal/MT+86, because I don't have an editor that works under CP/M-86, and thus without the SPP, I couldn't write Pascal programs to run with my 8088.

Actually, that's not strictly true: thanks to the chaps at RR Software, I have Vedit for CP/M-86; alas, due mostly to sloth, I have not yet installed it, which isn't really fair to the Vedit people. I'll have to get it up if I'm going to use the 8088 side of my dual processor, since it is, at the moment, the only general-purpose editor I have that can work with the 16-bit processor.

Anyway, when Jim Hudson was over to show me how to use the 8087 math chip in combination with Pascal/MT+86, he helped me get the SPP editor installed, and it works fine, as does the MT+ compiler. Unfortunately, the old Digital Research "technical writing" staff got hold of the SPP documents and did for them about what it did for Eubanks' CBASIC manual. We did get lucky, though: the Pascal/MT+86 manual seems to be essentially unchanged from the last MT+ version, except for a global replacement of MT+

with MT+86. In fact, it's somewhat improved, with a few additional examples.

Of course, it does have that irritating "All Information Presented Here is Proprietary to Digital Research" inanity at the bottom of each page. Even so, although the manual is not what I'd call exemplary, it hasn't been ruined either; and with the new team in Digital Research's document foundry, we can hope for an update that will be a real improvement.

Unmaligning the Osborne

In my December column I complained that the Osborne 1 lacks certain ASCII character keys. A dozen or more readers have written to tell me I was mistaken.

Although this is not documented anywhere that I (or any of those who wrote) know of, you can get the "missing" ASCII characters on the Osborne with the following key combinations:

Control-< produces { (Control-"less than" produces left curly brace)
Control-> produces } (Control-"greater than" produces right curly brace)
Control-/ produces ~ (Control-slash produces tilde)
Control-= produces ` (Control-equals produces accent grave)

I thank all those who took the trouble to inform me. Also, I appreciated the kind remarks many of you enclosed.

Fastest Benchmark Yet

I continue to get new data using my matrix-multiplication "benchmark of sorts" from the October column. This "test" fills two matrices with real numbers, multiplies them, then sums their elements to give a checksum. Although the algorithm used to fill the matrices produces integers, the elements should be declared as real numbers.

For a time, the record was held by the Sage II running UCSD Pascal. Then Jim Hudson came over and installed his piggyback 8087 board that rides on the Compupro 816 dual-processor machine, and that, running under Pascal/MT+86, took over the leadership.

Aaron Fox of the Department of Physiology at UCLA reports an even faster time. Fox writes:

> *Recently our lab acquired several Lomas Data Products computers. This computer has a 10-MHz Intel 8086 processor operating with fast static memory. The October BYTE, with your matrix-multiplication benchmark, was of particular interest to me since it gave more times to test our Lomas against. For a 20 by 20 matrix the times for the Lomas were as follows:*
>
> *2.9 seconds using Microsoft BASCOM-86*
> *34 seconds using Microsoft BASIC-86*
>
> *Thus, the 10-MHz 8086 is about 7.5 times faster than your 8085 for BASCOM, but only about twice for MBASIC. It seems that the interpreted BASIC is not a fast implementation. (This may explain why all the benchmarks I have seen with the IBM PC running interpreted BASIC are quite similar in speed to the same programs running on a 4-MHz Z80.)*
>
> *The point of this letter is that the 16-bit machines are* fast *and they are available with* software *today. As Sol Libes points out in the November BYTE, a 5-MHz 8086 is equivalent to 0.4 VAX, a fast and powerful machine . . .*

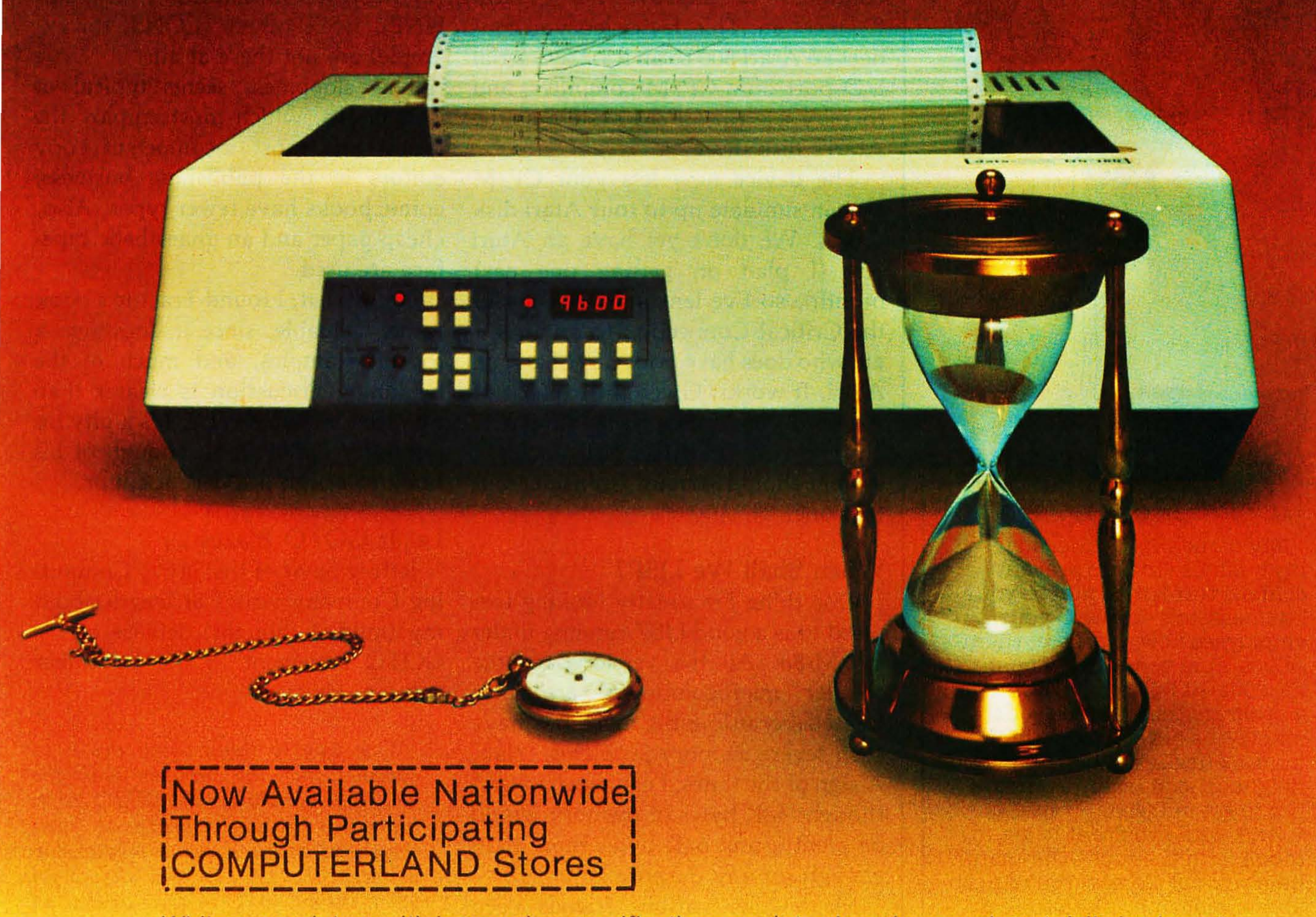
The Word, Revisited

I've received several letters asking about spelling programs. This is a subject of considerable interest to me, and I think I have tried every spelling program available for my machines.

I continue to use Wayne Holder's The Word Plus program, version 1.2, from Oasis Systems. This version allows me to transfer the programs, plus the dictionaries, over to a pseudo disk for really fast operation. The Word Plus has a number of nice features, including the ability to look up the word in its dictionary; if it sees anything it thinks might be what you intended, it offers it as a candidate spelling and gives you the opportunity to correct the word.

The Word Plus is fast and easy to use, and it offers me a lot of information, such as a table of the words I've used sorted by frequency of use, thus allowing me to see how many times I've used "alas" and such like. (Do

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people *really* prefer "unfortunately"? Alas, some have written to say they do.) The only improvements I'd make in The Word Plus have to do with defaults; I wish it would let me enter the name of the "specials" dictionary once and for all, instead of making me type in its name each time I invoke the program. That's hardly a major criticism. I can't imagine anyone not liking The Word Plus.

For All You Atari Users

Vincent Cate of USS Enterprises continues to improve his Critical Connection. This device lets you connect an Atari 800 to an RS-232C serial I/O port on a CP/M computer, and thereby use the CP/M system as the Atari's disk drive.

The device now lets your CP/M system simulate up to four Atari disk drives. We don't yet have an Atari 800 (I plan on getting one next month), so I've lent my test copy of the Critical Connection to an associate who does have both CP/M and an Atari. It works. Given the expense of Atari drives, and their slowness, anyone with an Atari and a CP/M system should seriously consider getting one.

When Shall We LISP?

One thing I'm greatly looking forward to is a good LISP running under CP/M-86. All the versions for the smaller microcomputers are very limited because 8-bit machines have such severe memory problems. (Hah. A sign of the times. I can recall when I thought 48K bytes of memory would be plenty, and 64K bytes more than enough for any purpose.)

Meanwhile, various friends keep urging me to try LISP. "Anything you can do in Pascal or BASIC you can do much quicker and more elegantly in LISP," they tell me. "How are you going to learn about artificial intelligence without it?" When I protest that I just don't know enough about LISP, they send me books.

So far I've successfully resisted learning LISP, but once there's a good version for my 8088 I fear I'll be doomed. Meanwhile, I can look over the books.

One, *Programmer's Guide to LISP* by Ken Tracton, is the darndest thing I ever saw. Some of it is absolutely clear, the easiest to understand discussion of parts of LISP that I've yet seen. Some of it is absolutely opaque. The really odd part, though, involves strange omissions.

The index, for example, is horrible. Many of the most important terms and concepts in LISP simply aren't there. No CONS, no CAR, no CDR, no LAMBDA. In another place there's a glossary of sorts, but some of the definitions are frivolous (LAMBDA—something like DEFINE), while others (CONS, for example) are not there at all.

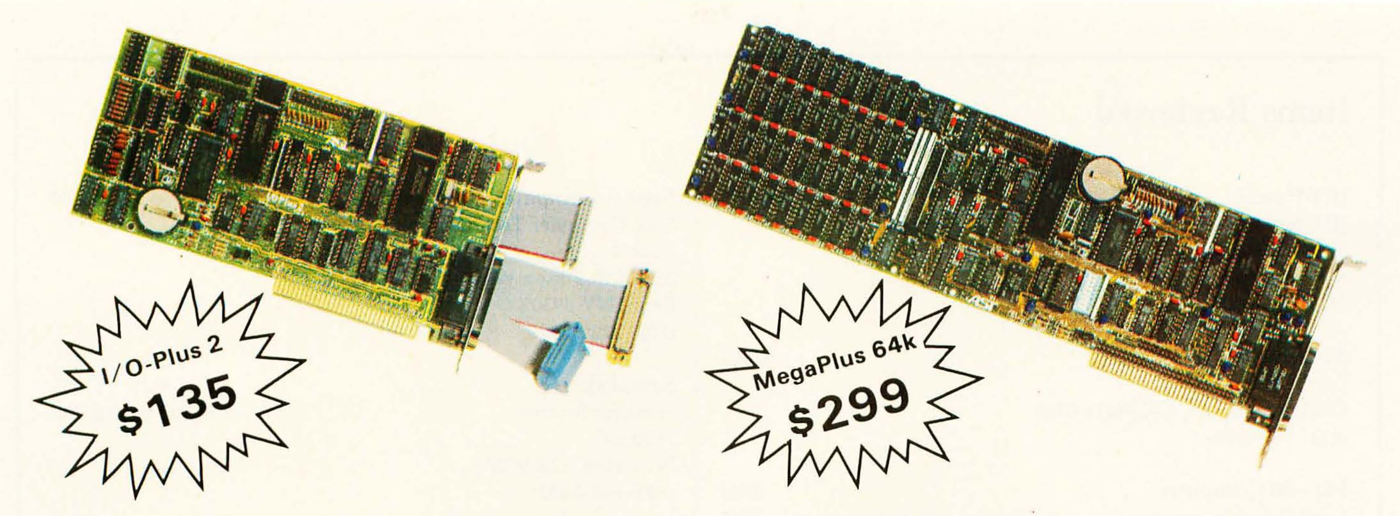
This sloppiness seems typical of Tab Books, which must employ the laziest and most incompetent copy editors in the publishing business; comic books have fewer typos. Also, cheap paper and an unaesthetic typeface are used.

For all that, I found Tracton's book rather valuable, since it does give a lot of examples, and much of the beginning discussion is clearer than I've seen anywhere else. It's a pity his publisher didn't think enough of his book to assign it a decent editor.

Let It GOTO Blazes . . .

Jeffrey Savit of the Savvy Computing Company writes at length about my (mild, I thought) defense of the GOTO statement in the December column. He says:

> *One way to think about this is to consider that the problem with the GOTO is not always the GOTO itself, but rather the label it arrives at. First, there is no enforced textual relationship between the GOTO and the target label. If the GOTO is being used as an escape from a loop, the label will appear immediately after the loop body, but there is no way for the compiler to know it was intended as an escape if the label is accidentally placed elsewhere in the program . . .*
>
> *The other problem with the label is that its presence means that there is less knowledge about the state of the program at the program text that follows it. The code after a label could have been reached by falling through the preceding text, or from any of the statements that GOTO the label. To understand this piece of the program the reader has to examine the entire program for GOTOs that might land there.*



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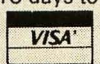
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Compupro Systems
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(415) 562-0636

Max-80 Computer $820
Lobo Drives International — with extra 64K-byte memory $915
358 South Fairview Ave.
Goleta, CA 93117
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(800) 235-1245 (outside California)

Minimum Data Base 8-inch $84.50
Pascal Introductory Package 8-inch $79.50
Workman and Associates
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Pasadena, CA 91106
(213) 796-4401

Modula-2 Compiler $495
Volition Systems Inc. — for Sage II (including text editor) $595
POB 1236
Del Mar, CA 92014
(619) 481-2286

Osborne 1 $1795
Osborne Computer Corporation
26500 Corporate Ave.
Hayward, CA 94545
(415) 887-8080

Printmate 150 Impact Dot-Matrix Printer A1 $1125
Micro Peripherals Inc. B1 $995
4426 South Century Dr.
Salt Lake City, UT 84107
(801) 263-3081

Sage II Computer $3600
Sage Computer Technology
Suite 4
35 North Edison Way
Reno, NV 89502
(702) 322-6868

Semidisk 512K $1995
Semidisk Systems 1 megabyte $2995
POB GG
Beaverton, OR 97075
(503) 642-3100

Speed Programming Package 8-bit $200
Digital Research 16-bit $250
POB 579
Pacific Grove, CA 93950
(408) 649-3896

The Critical Connection Not available
USS Enterprises
6708 Landerwood Lane
San Jose, CA 95120
(408) 997-0264

The Word Plus $150
Oasis Systems Inc.
2765 Reynard Way
San Diego, CA 92103
(619) 291-9489

Book Reviewed

Programmer's Guide to LISP $10.95
Ken Tracton. Blue Ridge Summit, PA: Tab, 1979. paper $6.95

Certainly it is possible to comment both the GOTO and the label to the effect that one and only one GOTO refers to that label, and that it is being used to escape from a loop, but that is precisely what a "leave" or "break" does without depending on the programmer not making a mistake . . .

On reflection, I agree with what Mr. Savit has said here. In my defense I'll point out (1) that Pascal has no "break," and my column speculated that a GOTO used as a substitute for "break" would do no harm, and (2) that "break" is one of the proposed extensions for the Pascal Prime Project.

In any event, Modula-2 has "break," and has no GOTO whatever; so if Modula-2 takes over from Pascal, this is one debate that will swiftly become history.

Coming Attractions

I much enjoyed COMDEX, not only for the software and equipment I saw, but for the people I met. For example, at the Zenith party I met John and Sue Matlock of Micro Peripherals Inc. of Salt Lake City. John had connected an MPI impact dot-matrix printer to a Zenith Z-100, and the printer was merrily making hard copy of everything that appeared on the Z-100 screen: words, symbols, graphics, swirls, and squiggles.

I've never had a dot-matrix printer, but that looked interesting. I got to talking with John Matlock about it.

The upshot was that in the next room sits an MPI Printmate 150 impact dot-matrix printer. Although it can be configured for driving by an RS-232C (serial) port, this one happens to expect a Centronics-style parallel input. There's a Centronics port on the Interfacer-4 board in my dual-processor system, but I don't recall precisely how Tony wrote that

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into the BIOS. Since he's in Arizona just at the moment, I can't hook up the Printmate 150 for a test run, although I expect to have it running next week.

Meanwhile, there's one hitch. Although it will work with a great many machines, a specific design goal of the Printmate 150 was that it would work with the Zenith Z-100 computer. The Zenith Z-100 was designed to be able to run IBM PC software, and as a result has the same hardware for connecting peripheral devices as does the PC. When IBM designed the PC, for some totally inexplicable reason it chose to put the same physical cable connectors on its Centronics-style parallel output port that other people use as RS-232C plugs and jacks.

This means that I have a printer expecting parallel input through a connector into which I can plug a serial input. Because the RS-232C cable carries 16 volts in pins that the Centronics port expects to have only signals, a mistake can blow up a fair number of chips. Worse, both the PC and the Z-100 have both serial and parallel outputs coming out of identical plugs, practically guaranteeing confusion. This is a disaster waiting to happen.

I hope to avoid the problem so that next month I can report on my new printer.

We've also just received a disk containing the source code to the Otrona's BIOS. Tony has been looking forward to playing with that; he has some improvements in mind. He's already got WRITE, my favorite text editor, transferred to the Otrona, so that I was able to take the Otrona to COMDEX and write up a good part of my trip report in my hotel room.

More on the Otrona, the new printer, and Modula-2 next month. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

Book Reviews

Microprocessor Systems, Interfacing and Applications

Robert J. Bibbero
and David M. Stern
John Wiley & Sons
1982; 192 pages
hardcover, $26.95

Reviewed by
Dr. William H. Murray
Computer Science Dept.
Broome Community College
Binghamton, NY 13902

Microprocessor Systems, Interfacing and Applications is an excellent introduction to microprocessors and data links in terms of signal paths and communication functions. Technically up to date and very readable, the book is aimed at "engineers, students, technicians, and managers who use microprocessors and design them into new devices and systems."

Wisely, Robert J. Bibbero and David M. Stern based their discussion not on a particular chip or family of processors but on a well-balanced cross section of current chips. In doing so, the authors successfully integrate the main concepts of their book throughout its seven chapters. To illustrate how they do this, I'll look at several chapters.

In the first two chapters, the authors quickly review digital logic and microprocessor fundamentals. As you might expect, they cover such topics as number systems, base changes (including fractional numbers), digital logic gates, and the architecture and instruction sets of popular microprocessors. Unfortunately the authors "squeezed" the three topics that form the cornerstone of their book into the first chapter. Address decoding, signal driving over transmission lines, and timing deserve closer examination; more examples would have helped. A detailed discussion of benchmarks in chapter two merits attention.

Chapter three addresses the problems of transmitting data. Logically presented with many helpful details, the discussion goes from signal buses to drivers and systems that include parallel and serial transmission of data. Particularly noteworthy is a section on microprocessor buses.

In chapters four and five, Bibbero and Stern contrast programming languages for microprocessors. Chapter four, devoted exclusively to BASIC, includes a good discussion of top-down structuring, flowcharting, algorithm development, and high-order languages. Unfortunately, the chapter is unspecific as far as actually writing BASIC programs goes. Chapter five looks at high-level languages such as FORTRAN, PL/I, FORTH, C-Code, and Pascal in terms of common points and strengths and weaknesses. More programming examples would have enhanced the discussion.

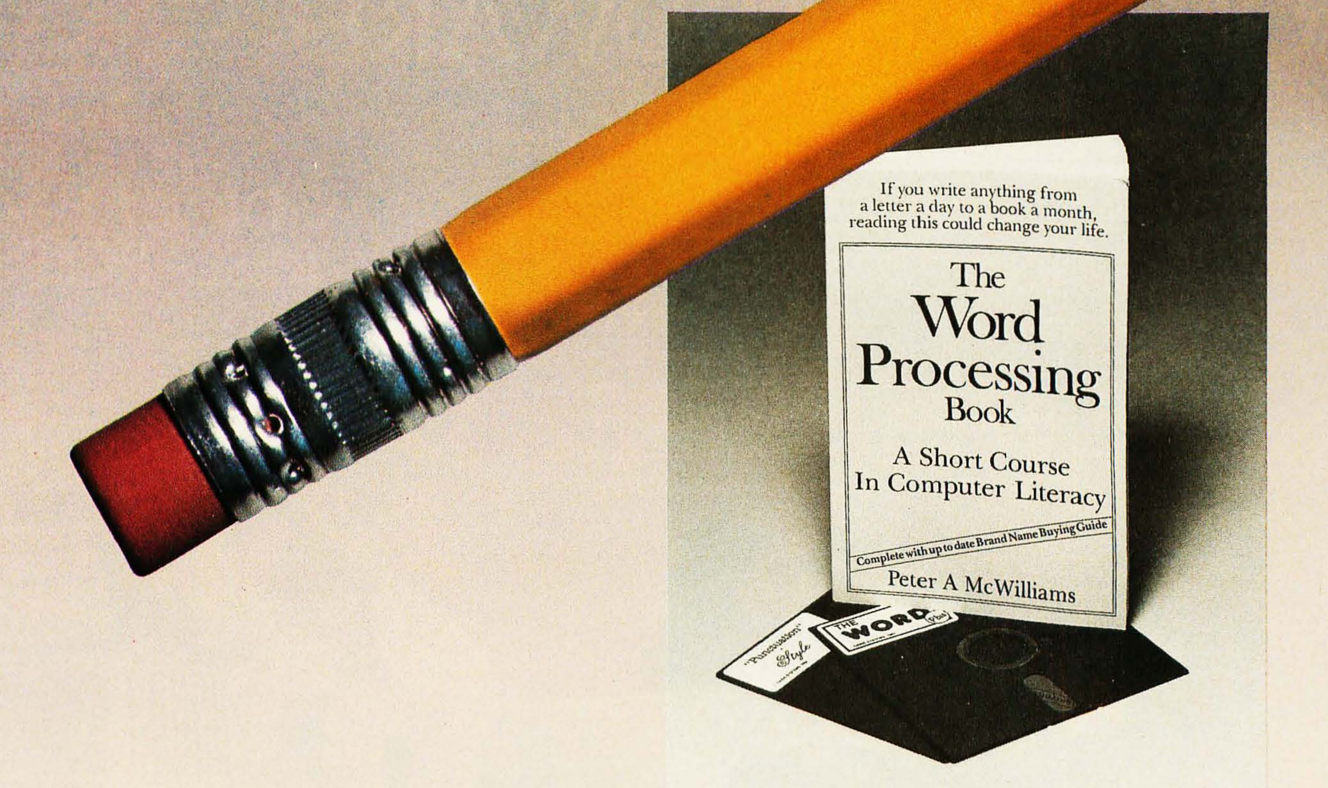
The chapter on device displays is typical of what you might find in most books on microprocessors. It describes the most popular displays, including seven-segment devices and CRTs.

Chapter seven deals exceptionally well with multiple microprocessor communication. Topics range from hierarchical processing layers, architecture and protocols of networks to topology, routing, and protocol. Ethernet and Proway are used to illustrate communications networks that operate between computers and microprocessor terminals.

I have just a few minor squabbles with the book as a whole. Because *Microprocessor Systems, Interfacing and Applications* covers so many topics in so few pages (192), many details are left out. For example, in the section that deals with addressing and decoding the authors give no examples of how an address decoder actually decodes. The authors attempt to illustrate several programming languages with examples, but again leave you begging for a few more details. And just a minor annoyance, but noteworthy, is that illustrations of digital logic gates do not conform to industry drafting standards.

Readers who have worked with digital electronics or microprocessors should have no difficulty with the concepts presented or vocabulary used. In fact, the text may be too elementary for experienced engineers, technicians, and managers. It is an excellent primer on the microprocessor and data link in terms of signal paths and communication functions and would be particularly useful in classroom instruction. ■

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The Enhanced VIC-20

Part 4: Connecting Serial RS-232C Peripherals to the VIC's TTL port

Joel Swank
12550 SW Colony #3
Beaverton, OR 97005

Owners of Commodore's VIC-20 personal computer know the fascination that can overcome the new computer user. Simplicity, of course, is both the VIC-20's main attraction and the reason for its low cost. And its uncomplicated nature makes the VIC-20 a good place for the beginner to start to explore the power of a microprocessor. But the real thrill comes with the machine's inevitable expansion to peripherals.

Commodore's Kernal operating system allows access to the VIC-20's serial user port. As a result, you can connect the VIC to modems, printers, and other serial devices. A modem opens the door to the world for the VIC-20. An ever-increasing number of information services are accessible via telephone lines: stock-market quotations, bulletin boards, and program exchanges are just a few examples, and many of these are free. With the proper software and hardware, two VIC-20 users can communicate directly to exchange programs and data.

The User Port

Table 1a summarizes the standard RS-232C pin assignments used with most microcomputer systems, and table 1b shows the pin assignments of the VIC-20's user port. Notice that the VIC-20 uses a subset of the standard instead of all the circuits defined in the standard (13 possible subsets are listed in the standard's application notes, but the VIC-20 subset does not match any of them). Commodore's *Programmer's Reference Manual* defines two possible subsets of the VIC-20's user-port interface: the X-line interface and the three-line interface.

Software access to the VIC-20's user port is via logical device 2. Routines in the Kernal provide proper timing and logic to send and receive data by this device. Users can also access the port by way of the BASIC statements OPEN, CLOSE, and I/O.

Overcoming Incompatibilities

The circuitry in the VIC-20 does not provide the voltages specified by the RS-232C standard; rather, it transmits data using TTL (transistor-transistor logic) level signals. In the VIC-20, signals between 0 V and 0.8 V (volts) represent a logical 0, while those greater than 2.4 V represent a logical 1. The RS-232C standard specifies that a logical 1 is any voltage more negative than −3 V, while a logical 0 is any voltage greater than +3 V. Thus the VIC-20 needs additional circuitry to properly interface with RS-232C devices.

Two ICs (integrated circuits) have been developed to solve this rather common problem. The 1488 contains four TTL-to-RS-232C line drivers, and the 1489 contains four RS-232C-to-TTL line receivers. These ICs are used in virtually every digital device that handles RS-232C voltage levels, and they're both inexpensive and easy to come by. You'll need one of each to build the VIC-20/RS-232C interface.

Editor's Note

This is the fourth and final article in Joel Swank's series on "enhancing" the Commodore VIC-20.

(1a)

RS-232C Interface Connector Pin Assignments

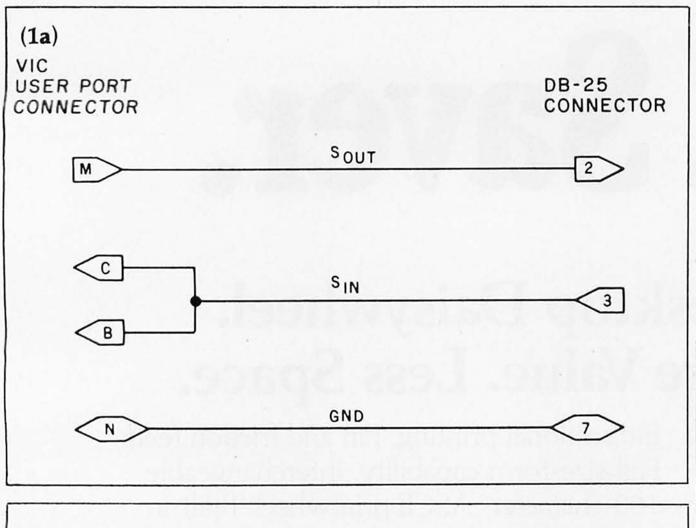
Pin Number	Circuit Name	Description
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground (Common Return)
8	CF	Received Line Signal Detector
9	—	(Reserved for Data Set Testing)
10	—	(Reserved for Data Set Testing)
11		Unassigned
12	SCF	Secondary Received Line Signal Detector
13	SCB	Secondary Clear to Send
14	SBA	Secondary Transmitted Data
15	DB	Transmission Signal Element Timing (DCE Source)
16	SBB	Secondary Received Data
17	DD	Receiver Signal Element Timing (DCE Source)
18		Unassigned
19	SCA	Secondary Request to Send
20	CD	Data Terminal Ready
21	CG	Signal Quality Detector
22	CE	Ring Indicator
23	CH/CI	Data Signal Rate Selector (DTE/DCE Source)
24	DA	Transmit Signal Element Timing (DTE Source)
25		Unassigned

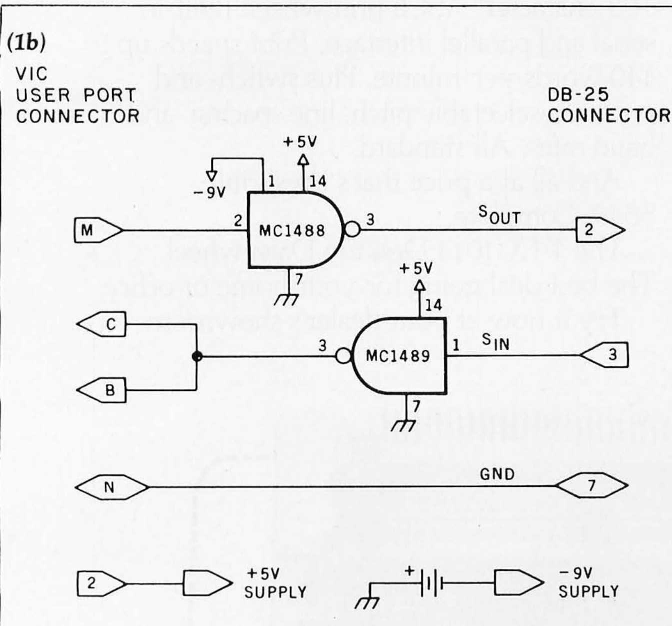
(1b)

User-Port Lines
(6522 Device 1)

Pin ID	6522 ID	Description	EIA Circuit	Abbreviated Name	Direction	Mode
C	PBO	Received Data	(BB)	Sin	IN	1 2
D	PB1	Request to Send	(CA)	RTS	OUT	1 2
E	PB2	Data Terminal Ready	(CD)	DTR	OUT	1 2
F	PB3	Ring Indicator	(CE)	RI	IN	3
H	PB4	Received Line Signal	(CF)	DCD	IN	2
J	PB5	Unassigned	( )	XXX	IN	3
K	PB6	Clear to Send	(CB)	CTS	IN	2
L	PB7	Data Set Ready	(CC)	DSR	IN	2
B	CB1	Received Data	(BB)	Sin	IN	1,2
M	CB2	Transmitted Data	(BA)	Sout	OUT	1,2
A	GND	Protective Ground	(AA)	GND		1,2
N	GND	Signal Ground	(AB)	GND		1,2,3

Table 1: *Pin assignments and signal names. The information in table 1a, a summary of RS-232C signals, comes directly from the RS-232C standard; the VIC's serial port signals, shown in table 1b, can also be found in Commodore's* Programmer's Reference Manual *for the VIC.*





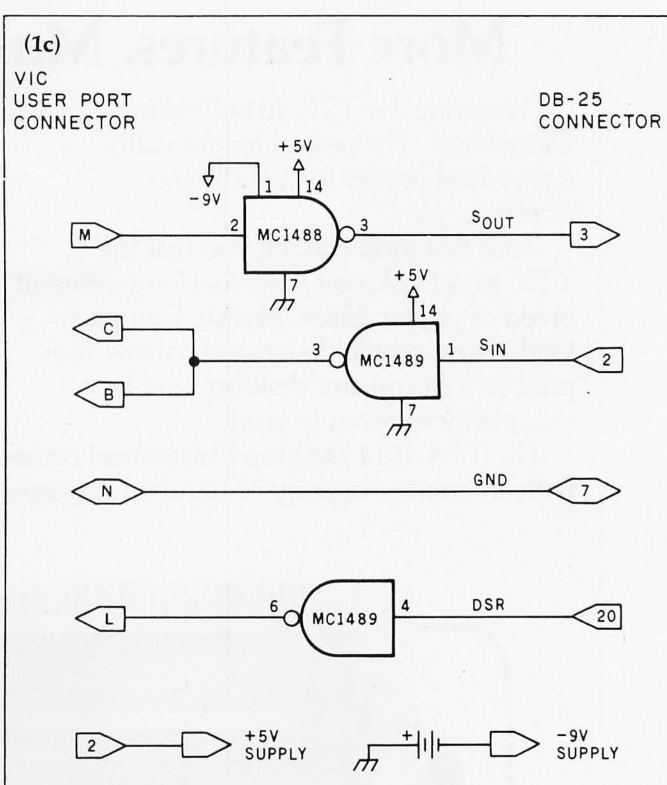


Figure 1: *Schematic diagrams of connections between the VIC and other equipment. In figure 1a, the VIC is connected directly to a TTL-level compatible modem. Figure 1b shows the arrangement for connecting RS-232C-compatible DCE (data-communications equipment, such as a modem) to the VIC's serial port; figure 1c shows connections to DTE (data-terminal equipment, such as a printer or video terminal).*

Connectors are another possible area of incompatibility: most RS-232C devices use a female subminiature D-type connector with 25 contacts termed DB-25 ; the VIC-20's connector is a card edge with 12 pins per side on 0.156-inch centers. If you intend to connect these two types of devices, you'll need a male DB-25 and a 24-pin edge-card connector.

Connecting to Serial Peripherals

Several modems will accept the VIC-20's TTL-level signals. Commodore sells one, of course, as do Bizcomp and Micromint. If you use the VIC modem, you need no additional hardware, but if you use another TTL-level device, you'll need to make a cable with the proper connectors on each end. Figure 1a shows how signals should be routed.

Figure 1b is a diagram of the signal adapter you'll need to connect the VIC-20 to full-duplex RS-232C peripherals. The Commodore manual refers to this adapter as the three-line interface. The biggest problem with this circuit is that it requires a negative power supply to match the voltage requirements of the RS-232C standard. I used a 9-V transistor-radio battery connected to provide negative voltage. (The circuit can be constructed on a small piece of perforated circuit board; the VIC connector is glued to one edge, and the DB-25 connector is attached by a three-wire cable.)

The user port can also communicate with a printer, a plotter, a video terminal, and several other RS-232C devices, but most of these, like the VIC-20, will be designed to fit the DTE (data-terminal equipment) category of the RS-232C standard. Because a DTE device is intended to be connected to DCE (data-communications equipment) instead of another DTE device, you have to fool both devices into thinking that the other is a DCE device. Figure 1c is a schematic diagram of how to accomplish that. It's simply a matter of using the same three signals used in figure 1b, but you also cross the wires and add a handshake line. This is the X-line interface Commodore refers to in its manual. The handshake

Text continued on page 338

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Listing 1: *The assembly listing of VICTTY, a program to send data to an RS-232C printer that requires handshaking signals.*

```
0001  0000                  ;   VICTTY : ROUTINE TO SEND TO THE VIC RS232 PORT.
0002  0000                  ;     FOR USE WITH AN OUTPUT ONLY DEVICE (PRINTER),
0003  0000                  ;     THAT REQUIRES HANDSHAKING.

0004  0000                  ;   THIS ROUTINE WAS ADAPTED FROM THE KIM/AIM MONITOR
0005  0000                  ;   TTY OUTPUT ROUTINES.

0006  0000                  ;   VICTTY ECHOS ALL CHARACTERS DISPLAYED ON THE SCREEN
0007  0000                  ;   TO THE RS232 PORT. IT WAITS ON THE DSR LINE
0008  0000                  ;   HANDSHAKE FROM THE OUTPUT DEVICE.

0009  0000                  ;   SET THE BAUD RATE BY POKING LOCATION 781 WITH ONE
0010  0000                  ;   OF THE FOLLLOWING:
0011  0000                  ; VALUE  BAUD RATE
0012  0000                  ;   0      110
0013  0000                  ;   1      150
0014  0000                  ;   2      300
0015  0000                  ;   3      600
0016  0000                  ;   4     1200
0017  0000                  ;   5     2400
0018  0000                  ;   6     4800
0019  0000                  ;   7     9600

0020  0000                  ; ACTIVATE WITH SYS 45056

0021  0000                  ; DE-ACTIVATE WITH SYS 45121

0022  0000                  ;   VIC USER VIA ADDRESSES

0023  0000                  DATAB1 =$9110           ;B PORT DATA REGISTER
0024  0000                  DDRB1  =$9112           ;B PORT DIRECTION REGISTER
0025  0000                  TIML   =$9118           ;TIMER 2 REGISTERS
0026  0000                  TIMH   =$9119
0027  0000                  PCR1   =$911C           ;PERIPHERAL CONTROL REGISTER
0028  0000                  IFR1   =$911D           ;INTERRUPT FLAG REGISTER

0029  0000                  ;   VIC TV CHIP

0030  0000                  TVCTL5 =$9005           ;TEST FOR LOWER CASE HERE

0031  0000                  ;   VIC RAM

0032  0000                  SYSX   =$30D            ;X REGISTER FOR SYS COMMAND
0033  0000                  DISVEC =$326            ;OUTPUT VECTOR

0034  0000                  ;   EQUATES

0035  0000                  LF     =10              ;LINE FEED CHARACTER
0036  0000                  CR     =13              ;CARRIAGE RETURN CHARACTER

0037  0000                         *=$B000

0038  B000  AD 27 03  ACT    LDA DISVEC+1     ;GET HI BYTE OF VECTOR
0039  B003  C9 B0            CMP #>VICTTY     ;MY ROUTINE?
0040  B005  F0 13            BEQ SKPVEC       ;YES, SKIP VECTOR UPDATE
0041  B007  8D 02 B1         STA VECSA+1      ;SAVE THE CONTENTS
0042  B00A  AD 26 03         LDA DISVEC       ;OF THE OUTPUT VECTOR
0043  B00D  8D 01 B1         STA VECSA
0044  B010  A9 55            LDA #<VICTTY     ;PUT ADDRESS OF MY ROUTINE
0045  B012  8D 26 03         STA DISVEC       ;INTO VECTOR
0046  B015  A9 B0            LDA #>VICTTY
0047  B017  8D 27 03         STA DISVEC+1
0048  B01A  AD 1C 91  SKPVEC LDA PCR1         ;USE CB2 IN DIRECT MODE
0049  B01D  29 1F            AND #$1F         ;FOR OUTPUT BIT
0050  B01F  09 E0            ORA #$E0         ;PUT A 'MARK' ON THE LINE
0051  B021  8D 1C 91         STA PCR1
0052  B024  A9 7F            LDA #$7F         ;SET B PORT HI BIT TO INPUT
0053  B026  8D 12 91         STA DDRB1        ;TO READ DSR LINE
0054  B029  AD 0D 03         LDA SYSX         ;GET BAUD RATE INDICATOR
0055  B02C  C9 08            CMP #BMAX        ;WITHIN LIMIT?
0056  B02E  90 02            BCC NOCLIP       ;YES, SKIP
0057  B030  A9 00            LDA #0           ;NO, DEFAULT TO 0
0058  B032  0A        NOCLIP ASL A            ;MULTIPLY BY 2 FOR INDEX
0059  B033  AA               TAX
0060  B034  BD 03 B1         LDA BAUDTB,X     ;GET CORRESPONDING ENTRY
0061  B037  8D FF B0         STA BITTIM       ;FROM BAUD RATE TABLE
0062  B03A  BD 04 B1         LDA BAUDTB+1,X   ;AND SAVE IN BITTIM
0063  B03D  8D 00 B1         STA BITTIM+1
0064  B040  60               RTS

0065  B041                  ;   ENTRY TO DE-ACTIVATE VICTTY

0066  B041  AD 27 03  DEACT  LDA DISVEC+1     ;GET HI BYTE OF VECTOR
0067  B044  C9 B0            CMP #>VICTTY     ;IS IT MINE?
0068  B046  D0 0C            BNE NOPE         ;NO, FORGET IT
0069  B048  AD 01 B1         LDA VECSA        ;YES, RESTORE OLD
0070  B04B  8D 26 03         STA DISVEC       ;VECTOR CONTENTS
0071  B04E  AD 02 B1         LDA VECSA+1
0072  B051  8D 27 03         STA DISVEC+1
0073  B054  60        NOPE   RTS

0074  B055                  ;   VICTTY : ROUTINE TO OUTPUT TO THE VIC RS232 PORT

0075  B055  8D FE B0  VICTTY STA CHAR         ;SAVE A COPY OF CHARACTER
0076  B058  48               PHA              ;SAVE ALL REGISTERS
0077  B059  8A               TXA              ;ON THE STACK
0078  B05A  48               PHA
0079  B05B  98               TYA
0080  B05C  48               PHA
0081  B05D  A9 02            LDA #$02         ;LOWER CASE MODE?
0082  B05F  2D 05 90         AND TVCTL5
0083  B062  F0 21            BEQ CHKCR        ;NO, SKIP TRANSLATION
0084  B064  AD FE B0         LDA CHAR         ;RETRIEVE CHARACTER
0085  B067  30 0F            BMI CHKUPP       ;CHECK FOR UPPER CASE
0086  B069  C9 41            CMP #'A'         ;LESS THAN 'A' ?
0087  B06B  90 18            BCC CHKCR        ;YES SKIPPIT
0088  B06D  C9 5B            CMP #$5B         ;GREATER THAN 'Z' ?
0089  B06F  B0 14            BCS CHKCR        ;YES SKIPPIT
0090  B071  09 20            ORA #$20         ;TRANSLATE TO LOWER CASE
0091  B073  8D FE B0         STA CHAR         ;SAVE IT
0092  B076  D0 0D            BNE CHKCR
0093  B078  C9 C1     CHKUPP CMP #$C1         ;LESS THAN 'A' ?
0094  B07A  90 09            BCC CHKCR        ;YES SKIP
0095  B07C  C9 DB            CMP #$DB         ;GREATER THAN 'Z' ?
0096  B07E  B0 05            BCS CHKCR        ;YES SKIP
0097  B080  29 7F            AND #$7F         ;CLEAR HI BIT
0098  B082  8D FE B0         STA CHAR         ;SAVE IT
0099  B085  AD FE B0  CHKCR  LDA CHAR
0100  B088  C9 0D            CMP #CR          ;RETURN?
0101  B08A  D0 08            BNE SEND         ;NO, JUST SEND IT
0102  B08C  20 B3 B0         JSR SENDTY       ;YES SEND IT
0103  B08F  A9 0A            LDA #LF          ;AND FOLLOW WITH A LINE FEED
0104  B091  8D FE B0         STA CHAR
0105  B094  20 B3 B0  SEND   JSR SENDTY       ;SEND A CHARACTER
0106  B097  68               PLA
0107  B098  A8               TAY              ;RESTORE ALL REGISTERS
0108  B099  68               PLA
0109  B09A  AA               TAX
0110  B09B  68               PLA
0111  B09C  6C 01 B1         JMP (VECSA)      ;GO DO NORMAL OUTPUT ROUTINE

0112  B09F                  ;   DELAY : DELAY FOR THE TIME IN BITTIM

0113  B09F  AD FF B0  DELAY  LDA BITTIM       ;MOVE DELAY TIME TO
0114  B0A2  8D 18 91         STA TIML         ;TIMER REGISTERS
0115  B0A5  AD 00 B1         LDA BITTIM+1
0116  B0A8  8D 19 91         STA TIMH
0117  B0AB  AD 1D 91  DEL2   LDA IFR1         ;TIME UP?
0118  B0AE  29 20            AND #$20         ;(TEST TIMER 2 BIT)
0119  B0B0  F0 F9            BEQ DEL2         ;NO, WAIT
0120  B0B2  60               RTS              ;YES, RETURN

0121  B0B3                  ;   SENDTY : SEND ONE CHARACTER TO THE RS232 PORT
0122  B0B3                  ;            THE CHARACTER MUST BE IN CHAR AND
0123  B0B3                  ;            IS NOT PRESERVED

0124  B0B3            SENDTY
0125  B0B3  78        WAITDS SEI              ;DISABLE INTERRUPTS
0126  B0B4  2C 10 91         BIT DATAB1       ;TEST DSR (PB7)
0127  B0B7  10 03            BPL SENDIT       ;IF ON, CONTINUE
0128  B0B9  58               CLI              ;ALLOW AN INTERRUPT
0129  B0BA  30 F7            BMI WAITDS       ;AND WAIT FOR DSR

0130  B0BC  20 9F B0  SENDIT JSR DELAY        ;DELAY A BIT TIME
0131  B0BF  A9 1F            LDA #$1F         ;PUT SPACE ON LINE
0132  B0C1  2D 1C 91         AND PCR1         ;TURN OFF CB2
0133  B0C4  09 C0            ORA #$C0
0134  B0C6  8D 1C 91         STA PCR1
0135  B0C9  20 9F B0         JSR DELAY        ;WAIT A BIT
0136  B0CC  A2 08            LDX #8           ;8 BITS TO SEND
0137  B0CE  4E FE B0  OUTLUP LSR CHAR         ;GET A BIT
0138  B0D1  90 0C            BCC BIT0         ;BRANCH IF ITS ZERO
0139  B0D3  A9 1F            LDA #$1F         ;ITS ONE -
0140  B0D5  2D 1C 91         AND PCR1         ;PUT A MARK ON THE LINE
0141  B0D8  09 E0            ORA #$E0
0142  B0DA  8D 1C 91         STA PCR1
0143  B0DD  B0 0A            BCS DELBIT       ;GO WAIT SOME
0144  B0DF  A9 1F     BIT0   LDA #$1F         ;PUT SPACE ON LINE

0145  B0E1  2D 1C 91         AND PCR1
0146  B0E4  09 C0            ORA #$C0
0147  B0E6  8D 1C 91         STA PCR1
0148  B0E9  20 9F B0  DELBIT JSR DELAY        ;WAIT A BIT
0149  B0EC  CA               DEX              ;COUNT THE BIT
0150  B0ED  D0 DF            BNE OUTLUP       ;LOOP TILL ZERO
0151  B0EF  A9 1F            LDA #$1F         ;SEND STOP BIT
0152  B0F1  2D 1C 91         AND PCR1         ;PUT MARK ON THE LINE
0153  B0F4  09 E0            ORA #$E0
0154  B0F6  8D 1C 91         STA PCR1
0155  B0F9  20 9F B0         JSR DELAY        ;WAIT A BIT
0156  B0FC  58               CLI              ;ALLOW INTERRUPTS
0157  B0FD  60               RTS

0158  B0FE                  ;  RAM LOCATIONS

0159  B0FE  00        CHAR   .BYT 0           ;OUTPUT CHARACTER
0160  B0FF  00 00     BITTIM .WOR 0           ;BIT DELAY TIME
0161  B101  00 00     VECSA  .WOR 0           ;SAVE FOR OUTPUT VECTOR

0162  B103                  ;  TABLE OF BAUD RATE BIT TIMES

0163  B103            BAUDTB =*
0164  B103  3F 23            .WOR $233F       ;110  BAUD (0)
0165  B105  B7 19            .WOR $19B7       ;150  BAUD (1)
0166  B107  C2 0C            .WOR $CC2        ;300  BAUD (2)
0167  B109  3F 06            .WOR $63F        ;600  BAUD (3)
0168  B10B  FD 02            .WOR $2FD        ;1200 BAUD (4)
0169  B10D  5D 01            .WOR $15D        ;2400 BAUD (5)
0170  B10F  8D 00            .WOR $8D         ;4800 BAUD (6)
0171  B111  2C 00            .WOR $2C         ;9600 BAUD (7)

0172  B113            BMAX   =8               ;MAXIMUM ENTRYS IN TABLE

0173  B113                   .END
0174  B113             ERRORS= 0000

SYMBOL DEFINED REFERENCES

A       0000   0058
ACT     0038
BAUDTB  0163   0062 0060
BIT0    0144   0138
BITTIM  0160   0115 0113 0063 0061
BMAX    0172   0055
CHAR    0159   0137 0104 0099 0098 0091 0084 0075
CHKCR   0099   0096 0094 0092 0089 0087 0083
CHKUPP  0093   0085
CR      0036   0100
DATAB1  0023   0126
DDRB1   0024   0053
DEACT   0066
DEL2    0117   0119
DELAY   0113   0155 0148 0135 0130
DELBIT  0148   0143
DISVEC  0033   0072 0070 0066 0047 0045 0042 0038
IFR1    0028   0117
LF      0035   0103
NOCLIP  0058   0056
NOPE    0073   0068
OUTLUP  0137   0150
PCR1    0027   0154 0152 0147 0145 0142 0140 0134 0132 0051 0048
SEND    0105   0101
SENDIT  0130   0127
SENDTY  0124   0105 0102
SKPVEC  0048   0040
SYSX    0032   0054
TIMH    0026   0116
TIML    0025   0114
TVCTL5  0030   0082
VECSA   0161   0111 0071 0069 0043 0041
VICTTY  0075   0067 0046 0044 0039
WAITDS  0125   0129
X       0000   0062 0060
```

Data Rate

value	bits per second
0	110
1	150
2	300
3	600
4	1200
5	2400
6	4800
7	9600

Table 2: *Data-transmission rate control values. One of these numbers should be stored in location 781 before VICTTY is activated in order to set the data rate.*

Text continued from page 334:
line is the DSR (data set ready) signal from the DCE device, whether it's a printer, a synthesizer, or some other peripheral. This signal must be sent to the VIC-20's DTR (data-terminal ready) input.

Handshaking is necessary because the VIC-20 can send data much faster than most serial devices can handle. At times, for example, a printer must ask the computer to stop sending data so that it can catch up. When the printer can handle more data, it informs the VIC-20 by asserting DTR.

Software

Unfortunately, an error in the VIC's serial data-transmission routines causes the computer to ignore signals on the DSR line. In other words, if the printer sends the "wait" signal, the VIC-20 ignores it and continues sending data, which is thus lost. To circumvent this problem, I use a program called VICTTY (adapted from the terminal-communications routines in the monitors of the KIM and AIM computers). See listing 1 on page 336.

VICTTY can be used to send data directly to the user port. While it bypasses all the fancy buffering done by the VIC's routines, it does pay attention to the DSR signal, waiting for the printer so that no data is lost. The program echoes to the printer any characters that are sent to the screen and is activated by entering SYS 45056 at the keyboard.

The transmission rate can be selected by using a BASIC POKE instruction to store a number in location 781 prior to activation. Unlike the VIC-20 routines that are limited to 1200 bps (bits per second), VICTTY will work at up to 9600 bps (see table 2 for data rates and the corresponding values to store).

To list a BASIC program currently in memory and send it to a 2400-bps printer connected to the serial port, for example, you would enter

```
POKE 781,5 : SYS 45056 : LIST
```

When the listing is done, deactivate VICTTY by typing SYS 45121 or all the screen output will be sent to the printer. You can also deactivate VICTTY by pressing the Run/Stop and Restore keys. VICTTY can also be used from within BASIC programs—just include the same POKE and SYS commands in the program before you send the output to the screen.

A Word about ASCII

It takes a bit of doing to make serial data from the VIC-20's port compatible with most standard printers. VICTTY alters the data as follows. First, it inserts a line-feed character after every carriage-return character (most terminals and many printers need both between lines). Second, it translates the VIC-20's uppercase/lowercase character set into standard ASCII (American National Standard Code for Information Interchange) characters. The VIC-20 has two characters sets: in one, the ASCII lowercase codes are replaced by special graphics characters; in the other, the ASCII uppercase codes produce lowercase characters, while the ASCII uppercase codes with the high-order bit on are used to produce uppercase characters.

Other Uses

In its present form, VICTTY can only handle transfers of data out of the computer, although the hardware is capable of both transmitting and receiving. Still, VICTTY could be used to echo VIC-20 screen output to an 80-column video terminal that would enable you to see more information at a time. If the terminal does not handshake, connecting pin 4 of the 1489-type line receiver to +5 V will enable the interface in figure 1c to work.

Other RS-232C devices can be used with this software/hardware combination; some might require you to modify the interface arrangement. The VIC routines supplied by Commodore can be made to work with the interfaces shown as long as handshaking is not required. With any luck, this series will start you on your way to exploring such advanced peripherals as plotters, digitizers, and speech synthesizers, all of which are now available for the home market. ■

The program in this article has been incorporated into a full-featured printer program for the Epson and other printers. It includes VIC graphics and access to all Epson functions via standard BASIC OPEN, CLOSE, and PRINT# statements (no SYS calls). It also has a special mode for BASIC listings that formats BASIC statements for readability. It will communicate to the printer via either a Centronics parallel interface cable or an RS-232C interface at up to 9600 bits per second with handshaking. For more information contact United Microware Industries Inc., 3503C Temple Ave., Pomona, CA 91768.

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Design Philosophy Behind Motorola's MC68000

Part 2: Data-movement, arithmetic, and logic instructions

Thomas W. Starnes
Motorola Inc., Microprocessor Division
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Last month, in part 1, I discussed the design philosophy behind the Motorola MC68000, a powerful 16-bit processor with multiple 32-bit registers. This month I'll describe the data-movement, arithmetic, and logic instructions of the MC68000. A thorough reading of the MC68000's user's guide (available from many computer bookstores and Motorola distributors) will give you all the details of each instruction's operation, but a look at the general categories of instructions, a discussion of why certain design decisions were made, and mention of some special capabilities of the instructions will give you insight into the power of this instruction set.

Instruction Format and Addressing Modes

Before I get into the instruction groups, let's first look at how assembly-language instructions are written. Table 1 illustrates a common instruction format and the choices that can be made within it. First, of course, you can pick one of several microprocessor instructions—for example, an addition (ADD), comparison (CMP), arithmetic shift left (ASL), or data move (MOV). If the instruction is one that handles data, you can, with the MC68000, select one of three data sizes: 8, 16, or 32 bits. This selection is made by following the mnemonic with a period and either a "B", "W", or "L", for byte, word, or long word; if no size is specified, the assembler will assume a 16-bit operation.

On a data operation, you need to make one or two more decisions, i.e., which addressing mode to use for the one or two operands the instruction requires. (See the text box on data organization on page 354 for more details.) Typically, you can select one of 14 modes; within most of these modes, one of eight address registers is selected. On many operations, you need to select a second addressing mode; this usually involves selection of one of eight data registers, but for the data-movement instruction, any addressing mode can be selected.

All MC68000 instructions are fully defined with 16 bits of *op code*. (Op code is short for operation code; it is the pattern of bits that a microprocessor interprets as a specific machine-language instruction executable by it.) Depending on the instruction or the addressing mode(s) selected, additional 16-bit extension words may follow the op code. These extension words provide additional addressing information and may make the total instruction length as long as 10 bytes. Because the instruction is always lengthened by multiples of 16 bits, you can ensure that instructions always begin on even-byte boundaries; because of the way the MC68000 fetches 16-bit quantities from memory, this placement of instructions increases the speed of program execution.

By far, the most common operation in any processor application is the movement of data. Other microprocessors move data with LOAD, STORE, PUSH, PULL, POP, and input/output (I/O) instructions. When you boil it all down, each instruction simply moves data from one location to another. So why not call them all MOVE? Simplicity of expression is a fundamental theme throughout the MC68000's instruction set: all similar operations should perform similarly in a number of respects. For example, if you can use an ADD operation with two 32-bit quantities, you should be able to use an add-with-carry operation with two 32-bit quantities. If you can select from 14 addressing modes to use an ADD operation, you should be able to select from 14 addressing

About the Author
Thomas Starnes is an electrical engineer who has spent the last five years helping to plan the direction of the MC68000 family of processor products for Motorola.

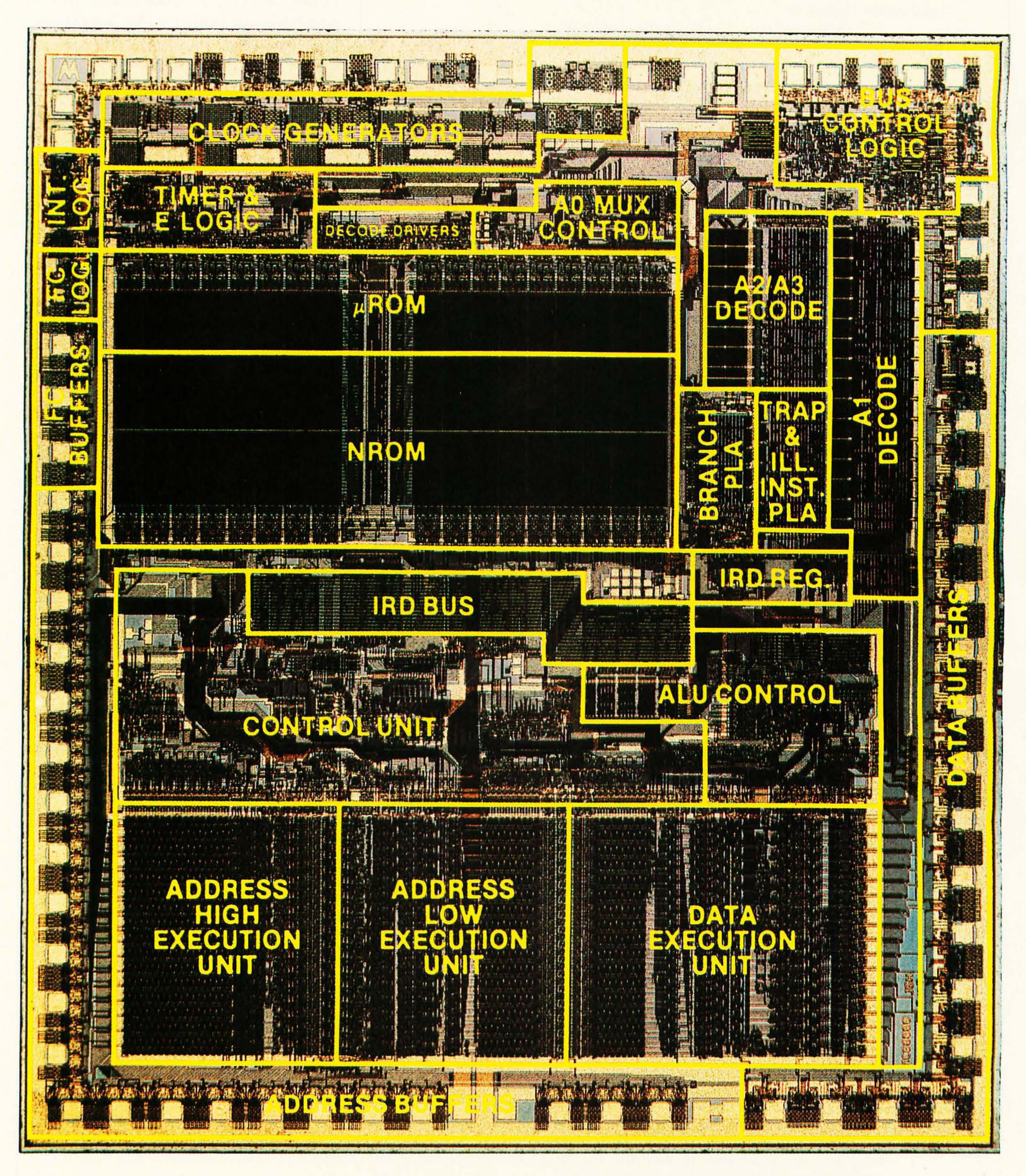


Photo 1: *The MC68000 microprocessor chip, which contains more than 68,000 transistors, is 246 by 281 mils (6.24 by 7.14 mm) in size. This photo shows the location of the major functions of the chip. "Int. Log." stands for "Interrupt Logic"; "A0 Mux Control", for "Microcode A0 Multiplexer Control"; and "FC Log.", for "Function Code Logic." The labels "μROM" and "NROM" indicate two areas of microcode. "Trap and Ill. Inst. PLA" stands for "Trap and Illegal Instruction Programmable Logic Array"; "IRD Reg.", for "Instruction Register Decode Register"; and "ALU Control", for "Arithmetic and Logic Unit Control." The Data Execution Unit houses the main functions of the arithmetic and logic unit, while the two Address Execution Units perform the arithmetic associated with the calculation of an address.*

```
Instruction format is:
          mnemonic.size      source,destination
Examples:
          ADD.L     D1,D2
          MOVE.B    #15, – 1(A0)
          ADD       D1,D2          (size assumed to be ".W")
          BGE       LOOP1          (only one argument)
          RTS                      (no arguments)

Explanations:
          mnemonic = instruction abbreviation (ADD, CMP, MULS, etc.)
          size (optional) = operand size:
                    .B   means byte data (8 bits)
                    .W   means word data (16 bits; default size)
                    .L   means long word data (32 bits)
          source (optional) = source operand addressing mode
          destination (optional) = destination operand addressing mode
```

Table 1: *General format for MC68000 instructions.*

modes to use SUB (subtract). If certain status register codes are modified to reflect the results of an ADD, the same codes should also be modified when a SUB or NEG (negate) instruction is performed.

Varieties of MOVEs

With this philosophy in mind, all of the old LOAD, STORE, PUSH, PULL, POP, and I/O instructions from other microprocessors were rolled into one very powerful and flexible MOVE instruction in the MC68000. Let's look at just what this one instruction can do.

The MOVE instruction can move 8-, 16-, or 32-bit data from practically any location to practically any other. And a wide selection of addressing modes and registers for both the source and the destination should cover about any way you want to find the operands. Table 2 lists the different combinations of addressing modes available on both the MC68000 and the Intel 8086 families. Let's look at what some of the MC68000 addressing-mode combinations allow you to do.

Certainly, you can copy data between registers, but you can also copy data to or from a register to memory using any of the memory-addressing modes. Most microprocessors allow the programmer to transfer data on the top of a stack to or from a register only. What if the data is really needed elsewhere in memory? You must run a second instruction to make the second move and use a register for a temporary holding space. The MC68000 allows you to move top-of-stack data to or from any register, another stack, a queue, any memory location, or any I/O location, all in one smooth motion. And why shouldn't you be able to? An added advantage of the MC68000 comes from its ability to use any one of the eight address registers as a stack pointer; this allows you to build as many as eight different stacks without having to swap out registers.

You can also do direct memory-to-memory moves. There are 10 different

	destination	Dn	An	(An)	(An) +	– (An)	d16(An)	d8(An,Xn)	Abs.W	Abs.L
	#options	8	8	8	8	8	8	128	N/A	N/A
source	#options									
Dn	8	MI	MI	MI	M	M	MI	MI	MI	M
An	8	MI	MI	MI	M	M	MI	MI	MI	M
(An)	8	MI	MI	MI	M	M	M	M	M	M
(An) +	8	M	M	M	M	M	M	M	M	M
– (An)	8	M	M	M	M	M	M	M	M	M
d16(An)	8	MI	MI	M	M	M	M	M	M	M
d8(An,Xn	128	MI	MI	M	M	M	M	M	M	M
Abs.W	N/A	MI	MI	M	M	M	M	M	M	M
Abs.L	N/A	M	M	M	M	M	M	M	M	M
d16 (PC)	1	M	M	M	M	M	M	M	M	M
d8 (PC,Xn)	16	M	M	M	M	M	M	M	M	M
Immediate	1	M	M	M	M	M	M	M	M	M

Notes:
1. "M" means this combination available on the Motorola MC68000.
   "I" means a comparable combination available on the Intel 8086 family.
2. "#options" refers to the number of different ways an addressing mode can be used in the MC68000 due to the availability of multiple registers that can be used; for example, the "d8(An,Xn)" option can use 8 An registers and 16 Xn registers for a total of 128 combinations. "N/A" means "not applicable."
3. Most of the source and destination addressing modes are explained in the text box "Data Organization and Addressing Modes," page 354. "An" and "Dn" are register addressing modes. "Abs.W" and "Abs.L" are word-address and long-word-address forms of absolute addressing.

Table 2: *Addressing modes available to the Motorola MC68000 and the Intel 8086. The information at the intersection of a row and a column indicates the availability of that source/destination addressing-mode combination for each microprocessor.*

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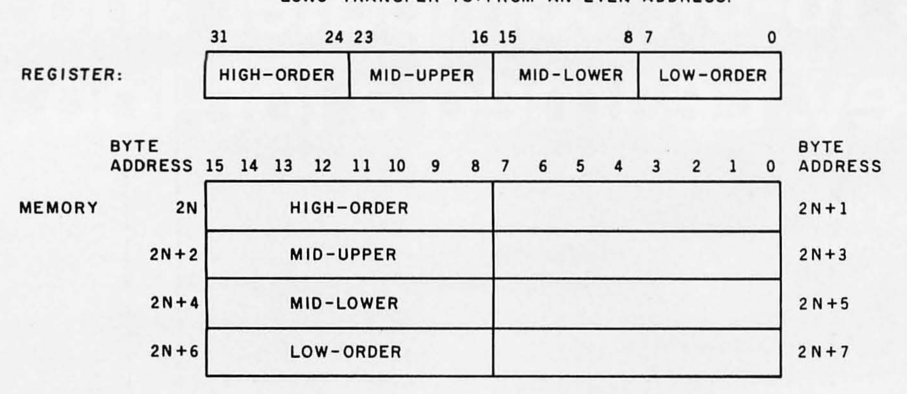


Figure 1: *Moving data from a 32-bit register to memory using the MOVEP instruction. Bytes from the register are stored in every other memory byte. The instruction takes 24 clock cycles to execute.*

memory-addressing modes to select from for the source operand and seven for the destination. Also, keep in mind that each addressing mode can use any of the eight address registers, further increasing the versatility of these move instructions. (Actually, in one mode, you have 16 registers to choose from—eight address and eight data registers.)

Just how many different ways are there to move general data in the MC68000? When you couple all of the combinations allowed with the selection of registers available, there are 34,888 different ways, and each one can be used for 8-, 16-, or 32-bit data. That ought to solve most programmers' data-shuffling problems!

The remaining data-movement instructions include SWAP, for instance, which exchanges the contents of any two data and/or address registers. You can read or modify the status register codes with a MOVE SR (Status Register) instruction.

The MC68000 was designed to interface directly to the MC6800 line of 8-bit peripherals so that all the existing peripheral circuits could easily be used on the MC68000. (Many of the 8-bit peripherals provide very useful functions that would need to be included in a 16-bit system.) To bring the best of the 8-bit peripheral world into the universe of 16-bit software, designers included a special MOVEP (Move Peripheral) instruction in the MC68000. Here's how and why it works.

Frequently, you must set up registers to ready a peripheral for operation. You need to connect an 8-bit peripheral to either the upper or lower half of the 16-bit-wide data bus. This means that the registers connected to a peripheral appear within the MC68000 memory address space as successive-even or successive-odd addresses. The MOVEP instruction will move either 16 or 32 bits of a given data register out to memory in 8-bit chunks, starting at a given location (see figure 1); addresses for each successive byte are incremented by two, not by the one that the normal MOVE uses. This allows the 2 or 4 bytes being transferred to be loaded into the proper peripheral port addresses. Thus, you can load as many as four 8-bit registers in one simple instruction. The MOVEP instruction is bidirectional, so that the registers can be either loaded or read.

Two special types of the MOVE instruction are the MOVEQ (Move Quick) and the MOVEM (Move Multiple Register). Often a register is used as a counter or a constant, with values that are typically rather small. The MOVEQ instruction makes it fast and easy to initialize a register to such values. MOVEQ will take any signed 8-bit immediate value between −128 and 127, extend its sign bit so that it will be correctly interpreted as a 32-bit number, and load it into one of the data registers. The op code for MOVEQ includes the 8-bit immediate value; this means the microprocessor can perform the operation very quickly. Because the small immediate value is part of the MOVEQ op code itself, the instruction is classified as a separate addressing mode of the MC68000 called the "quick immediate" addressing mode.

It is common in machine-language programming to have to save the contents of various on-chip registers, use the registers for some other purpose, and then restore their former contents. This happens when you are beginning or ending a subroutine, executing an interrupt handler, changing tasks, or calling the operating system. The MC68000 has a very handy instruction that makes this a fast, efficient operation. The MOVEM instruction will take any combination (or all) of the 16 data and address registers and move them either to or from memory in an organized manner. These registers can be transferred to or from any stack or to a specific location in memory. They are put in memory and taken from memory in reverse order to ensure that each register receives its proper contents. An option of the MOVEM instruction is that either the lower 16 bits of the registers or the entire 32-bit registers can be transferred. An example of this instruction is:

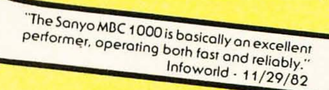
```
MOVEM.L D0/D4-D7/A4/A5,40(A6)
```

which would save the registers as shown in figure 2. (The instruction will save registers D0, D4 through D7, A4, and A5 into memory starting at the location pointed to by the value in register A6 plus the value 28 hexadecimal.) The list of registers to be transferred is compactly encoded in a 16-bit value that follows the MOVEM op-code word—an "on" bit indicates the associated register is to be transferred. Not only is the MOVEM instruction both compact and useful, it is also as fast as possible for the number of bytes of information that must be transferred.

Orthogonality

Arithmetic operations are key instructions in a microprocessor because they tend to be the ones that

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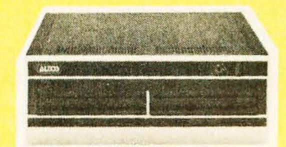
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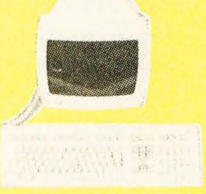
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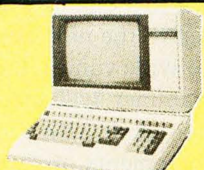


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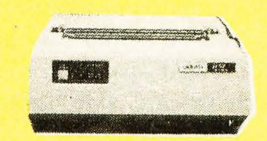
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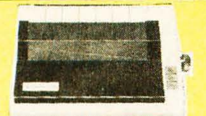
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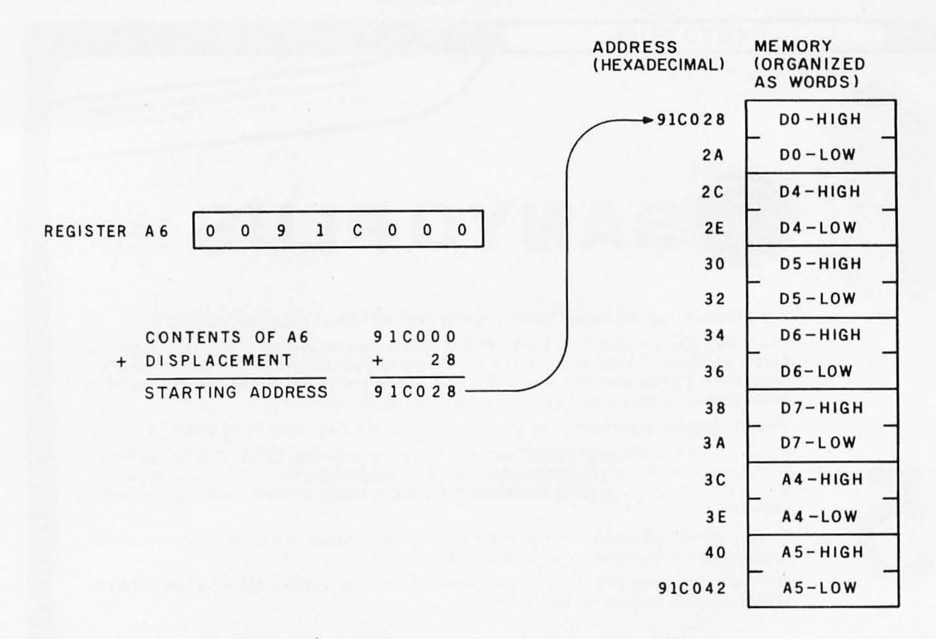


Figure 2: *Pushing multiple registers to memory with the MOVEM instruction. This instruction offers a very fast way to store selected registers in memory and, later, restore them properly. This figure shows the storage of registers D0, D4 through D7, A4, and A5 to location 91C028 hexadecimal. The instruction itself is MOVEM.L D0/D4-D7/A4/A5,40(A6). (Remember that 40 decimal equals 28 hexadecimal.) The instruction takes 58 clock cycles to execute.*

do the bulk of the work. The arithmetic and logic instructions allow programmers to write code exactly as they desire without having to rearrange data, gather more data, or do things in an unnatural order. As with so many other characteristics of the MC68000, the design of the arithmetic and logic instructions is very orthogonal—more so than for any previous microprocessor. *Orthogonality* can be defined as the ability of any allowed operation to use any resource in any way that any other operation may.

The arithmetic and logic instructions are very similar in the way they function, the way the condition codes are affected as a result, and the selection of addressing modes, registers, and operands available to them. The advantage of this is that, when coding, the programmer has only one uniform set of rules to remember. Older microprocessor designs forced programmers to have different sets of rules for even similar instructions, which decreased programmers' productivity by forcing them to recall and use correctly large amounts of essentially arbitrary information.

All of the dual-operand arithmetic instructions are true "one-and-a-half" address operations (i.e., one operand can be specified as a memory address, but the other must be an internal register—the result overwrites one operand). Thus, you can add any register to any register, a constant to any register, the top of a stack to any register, a value buried in a stack to any register, a table entry to any register, an input from an I/O device to any register, or any memory location to any register. Or, because the order may be reversed, you can add any register to any of the same (except that you can't add to a constant, and you can't use the program-counter relative addressing mode to specify a destination). Also, remember that any of these instructions can occur with 8-, 16-, or 32-bit data.

Arithmetic Instructions

Let's look at the types of arithmetic instructions that are available. Add (ADD), subtract (SUB), and compare (CMP) instructions are general two-operand instructions. ADDX and SUBX are used to work on numbers longer than 32 bits (the X condition bit in the MC68000 performs a function similar to the one the carry bit performs in most microprocessors). Two multiply and divide instructions are available: signed (MULS and DIVS) for single-precision instructions and unsigned (MULU and DIVU) for multiple-precision instructions.

The negate (NEG) and clear (CLR) instructions require only a single operand, and you can use a NEGX to negate multiple-precision values. To blend mixed sizes of data, the MC68000 provides a sign-extend instruction (EXT), while a TST (test) instruction is used to check for positive, negative, or zero conditions. A special instruction, the indivisible test-and-set (TAS), provides software synchronization in multimicroprocessor operations.

One variation on the ADD instruction enables the MC68000 to overcome a common limitation of other microprocessors. The normal "one-and-a-half" address design of most processors makes it difficult to use constant (immediate) values with anything but registers. The MC68000 overcomes this with the ADDI instruction, which allows a byte, word, or long-word immediate value to also be added to an operand in memory using any legal destination-memory addressing mode.

The MC68000 has no increment or decrement instructions. Why? Remember, the idea is to treat all similar instructions the same. An increment instruction adds 1 to a quantity and is often used to step to the next element in a table of byte-wide values. But the MC68000 programmer will often be manipulating 16- and 32-bit data, which require increments of 2 and 4, respectively, to the table address. The design team wanted to generalize the increment and decrement instructions to make them useful with all data sizes yet still retain the speed associated with an instruction that does not have to fetch an immediate argument. To solve these problems, and then some, the designers gave the MC68000 "add quick" (ADDQ) and "subtract quick" (SUBQ) instructions, which allow any number from 1 to 8 to be added to or subtracted from any register or any memory location. The instructions accomplish this in the shortest possible time by using 3 bits within the 16-bit op code to hold the increment or decrement

Text continued on page 352

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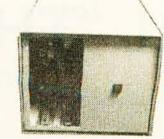
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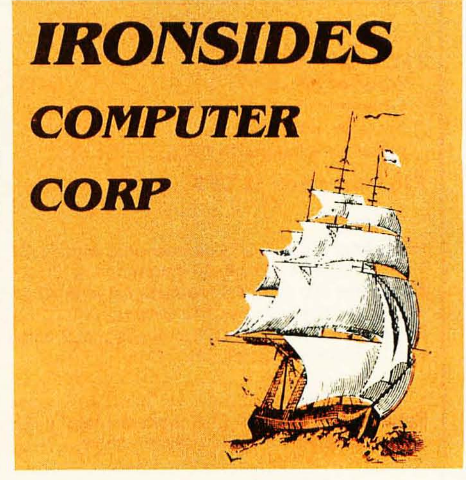
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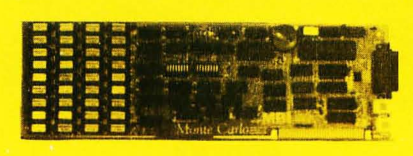
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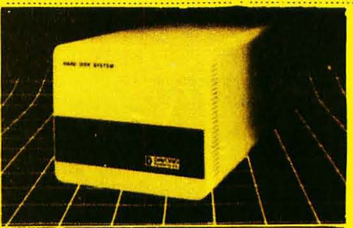
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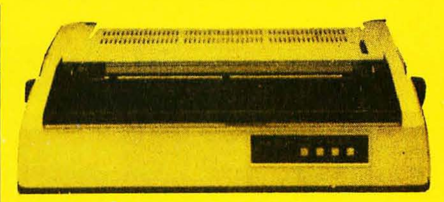
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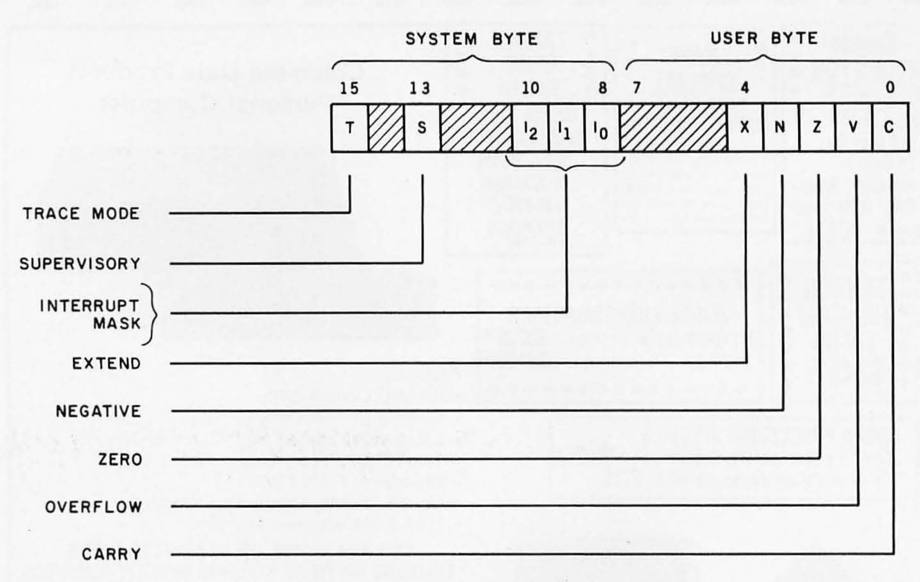


Figure 3: *The bits of the MC68000 status register (SR).*

amount (in this scheme, the bits 000 indicate an operand value of 8, not 0). Then, not only can you quickly and easily change an address pointer by 1, 2, or 4 for 8-, 16-, or 32-bit data, but you can also change counters by 3, 5, 6, 7, or 8. And the effect is identical to that using the standard ADDI instruction—even the status register codes are all the same.

Some odds and ends of arithmetic instructions include sign-extend (EXT), clear (CLR), and test (TST) instructions. Since three different sizes of data can be used in the MC68000, there should be a convenient way of changing size. If you want to move only part of a datum (for example, the bottom 16 bits of a 32-bit register), you need only use a MOVE instruction of the proper data size. If, however, you want to convert a datum to a larger-sized two's-complement value (for example, making a 16-bit value into a 32-bit expression), you need a special instruction. The EXT instruction will take an 8-bit or a 16-bit datum and duplicate its uppermost bit position through the higher portions of any data register in order to convert the datum to 16 or 32 bits wide, respectively. CLR simply loads a set of 0s into the destination. TST sets the negative and zero condition bits (discussed in the next section) according to the nature of the given operand.

Status Register Codes and Multiple-Precision Arithmetic

What if you are dealing with binary integers that require more than 32 bits for expression? Say you want to add two 128-bit (16-byte) numbers. If both of these numbers were in the MC68000 registers, all eight data registers would be in use. More likely, the two values would be in 16 consecutive bytes of memory, starting with the most significant byte of data. The normal procedure to add two such numbers is to add the two least significant bytes, remember the carry, go to the previous bytes and add them, remember the carry, and so on. This sequence of operations is handled neatly in the MC68000 by the predecrement address-register deferred mode, which uses the notation "−(An)". Use two address registers to point to the byte just past each operand. Each execution of an ADDX −(Am), −(An) instruction will decrement the values in the Am and An registers (m and n stand for numbers between 0 and 7), then add the two numbers pointed to by those registers. By putting this single instruction in a loop, you can quickly create the code needed to operate on multiple-precision numbers.

Let's detour for a second to discuss the status register of the M68000 (see figure 3). It contains the standard carry (C), overflow (V), zero (Z), and negative (N) bits found in other microprocessors. It also has a status-register bit not found on other microprocessors, the X (or extend) bit. This bit was created to eliminate confusion caused by traditional overuse of the carry bit.

To explain the extend bit, I should describe the carry bit. In most microprocessors, the carry bit is overused. It is changed by (among other things) an addition instruction, but it is used in two different ways. Sometimes it is used in a later addition, such as in multiple-precision additions; sometimes a program tests the bit and branches according to the carry bit's state. So programmers use the carry bit for two different purposes: for extended-precision arithmetic and for program control.

The MC68000 has a bit for each purpose. Both the carry and the extend bits are changed according to the results of an addition instruction. However, the carry bit is used by the microprocessor during testing for program control purposes, while the extend bit is used as an input for multiple-precision arithmetic operations. For ADD, SUB, NEG, and specified shift and rotate instructions, both the carry and extend bits are updated. Other instructions—MOVE, AND, OR, TST, CLR, MUL, and DIV—change only the carry bit. This design helps prevent inadvertent changes to either bit.

Because of the extend bit, the familiar "add with carry" operation in the MC68000 becomes ADDX or "add with extend bit." Look at why this is important. Once you start a multiple-precision arithmetic operation and get a partial result, the integrity of the extend bit will be maintained even if you have to suspend the addition to do some data movement with the MOVE instruction. Programming becomes easier because you don't have to save the status register codes when interrupting a multiple-precision operation.

I should mention one other thing about multiple-precision arithmetic. When you have finished the multiple-precision operation, what does the negative bit mean? It correctly indicates that the result was positive or

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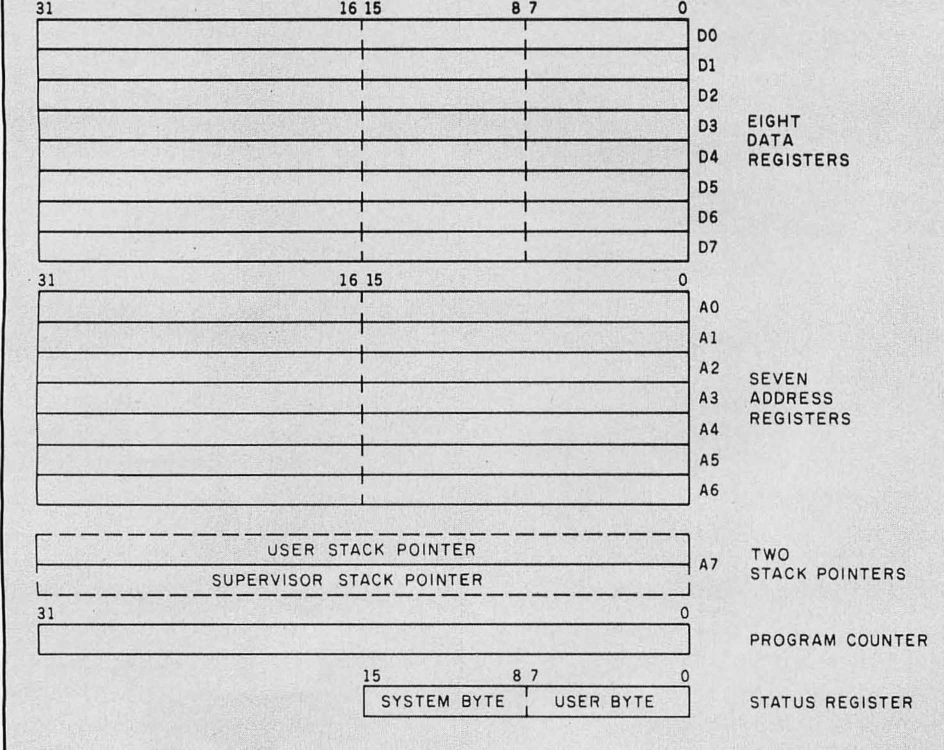
Data Organization and Addressing Modes

Motorola designed the MC68000 to offer a versatile set of data sizes and addressing modes for the assembly-language programmer. To understand fully the power of this machine, you must first understand how the MC68000 organizes and moves data.

Although the MC68000 "sees" its memory space as a collection of 8-bit bytes, it works on several different data sizes. It can address memory in the following sizes: byte (8 bits), word (16 bits), and long word (32 bits). In addition, it can manipulate individual bits—a bit is specified by the byte it is in and its bit number (between 0 and 7) within the byte.

The MC68000 has a definite preference for addressing 16- and 32-bit quantities that start at even addresses. In particular, it was designed to access quickly 16-bit quantities that start on an even address. Even though this speed comes at the expense of words and long words that begin at odd addresses (which would take two, not one, fetch operations to be accessed), this is not a serious disadvantage. MC68000 op codes are always 16 bits wide, and any arguments the MC68000 requires are always stored as one or more 16-bit words (even if the argument is only a byte quantity). Because of this, code that starts on an even-byte boundary will stay on an even-byte boundary and thus will be accessed at the fastest rate possible.

The MC68000 register set (see the figure) indicates the microprocessor's commitment to long-word data: even though this is a 16-bit machine, all the internal registers are 32 bits wide. The dotted lines in the data registers denote those registers' ability to handle 8-, 16-, or 32-bit-wide data. The address registers can handle either 16- or 32-bit-wide data.



The MC68000 supports six major addressing modes; although I will not go into the variations available in each mode, a short description of each will show you the basic ways the microprocessor can get its operands.

- *Inherent addressing: the instruction itself tells the microprocessor where to get its operand. An example of this is RTS, return from subroutine, which gets the return address from the stack.*
- *Register addressing: the operand is a data or address register. An example is MOVE D1,D2, which moves the contents of data register D1 to data register D2.*
- *Immediate addressing: the operand is specified as part of the instruction. An example is MOVE #3,D2, which moves the value 3 into data register D2.*
- *Absolute addressing: the operand is specified by a 16- or 32-bit address that is appended to the instruction. An example is MOVE $3F01,D2, which*

negative. In most microprocessors, though, the zero bit indicates only that the most significant portion of the result is 0, not that the entire result is 0. The multiple-precision arithmetic instructions in the MC68000 are designed so that the zero bit will accurately depict the status of the entire result. This is done by allowing multiple-precision instructions to reset the zero bit (denoting a nonzero result) but not to set it (denoting a zero result). With this scheme, the programmer's only responsibility is to set the zero bit before beginning the multiple-precision operation.

One final issue can come up in the middle of arithmetic operations, and the MC68000's handling of the problem illustrates another fundamental difference between it and so many other microprocessors. How many times have you interrupted a series of arithmetic operations to modify some memory pointers and later discovered that your completed arithmetic operation gave a wrong result because you inadvertently modified certain status register code bits? When you get right down to it, when you add 12 to a memory address, who cares if a carry was generated or if the result was negative? In fact, the negative bit has no meaning in relation to addresses. We as programmers are hurt

moves the contents of the word at address 3F01 hexadecimal into data register D2. This is also called direct addressing *because the operand address is being directly supplied.*

- *Register-deferred addressing: this mode has a lot of variations. Since these modes get rather complicated, I'll speak of them in terms of what the effective address is—that is, what memory location will be used to supply the source or destination operand. The simple* address-register deferred mode *makes not the register but the* contents *of the register the effective address. Because the register contents is itself the address of the given operand, this addressing mode is often called* indirect addressing*—the register indirectly supplies the effective address. Suppose that register A1 contains the value 100 and that the word at address 100 contains 12D hexadecimal. Then the instruction MOVE (A1),D2 will put the value 12D hexadecimal into data register D2. The notation "(An)" denotes address-register-deferred (or indirect) addressing using data register An.*

Two related variations on address register deferred are called address-register deferred with predecrement *and* address-register deferred with postincrement*; they have notations of "−(An)" and "(An)+", respectively. In the predecrement variation, the address register An is decremented before its contents is used as the effective address; in the postincrement variation, the contents of the address register is used as the effective address, then the register is incremented. These modes are often used in loops for repetitive operations on sequential areas of memory; they usually replace an explicit increment or decrement instruction, thus providing more compact, faster code. The incremental or decremental amount will be 1, 2, or 4 depending on whether the operand is a byte, word, or long word.*

Another variation is called address-register deferred with displacement*; in this mode (denoted "d16(An)"), the effective address is the contents of address register An plus the signed 16-bit value d16. Suppose address register A1 contains the value C100 hexadecimal and the word at address C25E hexadecimal contains 0. Then the instruction MOVE $15E(A1),D2 moves the value 0 into data register D2. (The effective address, C25E hexadecimal, is the sum of the displacement 15E hexadecimal and the contents of register A1, C100 hexadecimal.)*

The variation called address-register deferred with index and displacement *(denoted "d8(An,Xn)") limits the displacement to an 8-bit signed number but makes the effective address the sum of three numbers: the displacement, the contents of the address register An, and the contents of an index register Xn, where the index register can be any of the address or data registers. The extra register is added into the effective address calculation to allow the same instruction to point to the base of a table (using d8 and An) and, during execution, to refer to different nearby memory locations by putting different values into the index register Xn. The word "index" in the addressing mode name refers to the commonplace use of the index register to index into an array of numbers stored sequentially; in such a case, the value in the index register equals the subscript of the array element desired. Given the example directly above (register A1 contains C100 hexadecimal, word C25E hexadecimal contains 0) and the information that data register D6 contains is the value 100 hexadecimal, the instruction MOVE $5E(A1,D6),D2 moves the same value (0) to data register D2 just as the instruction MOVE $15E(A1),D2 would. In both cases, the effective address is C25E hexadecimal.*

- *Program-counter relative addressing: this mode has two variations, "d16 (PC)" and "d8 (PC, Xn)"; these are similar to the two forms of address-register deferred addressing described above. It is different in two ways: first, it uses the program counter (PC) instead of an address register; second, you cannot use this mode to specify a destination operand. The main advantage of this mode is that it allows you to write position-independent code. Because the program counter contains the address of the next instruction after the one currently executing, its use allows the current instruction to refer to data (or program locations for branches) relative to the instruction itself. The MC68000 designers included the restriction against using this mode for a destination operand to protect a program with errors from inadvertently destroying itself. In addition, this restriction prevents programmers from writing self-modifying code, a dangerous practice that programmers occasionally try to increase program performance.*

by the senseless changing of status register code bits when address-related operations are run. Why don't we leave these bits alone when changing memory addresses?

As you can imagine, the designers of the MC68000 have addressed this problem. One of the primary distinctions between the data and address registers in the MC68000 is that instructions with an address register as the destination do *not* modify the status register code bits. They are not changed by moving a new pointer value into an address register, incrementing or decrementing an address register, or by adding any value to an address register. This means that you should never run into a problem with memory-pointer modifications affecting your ongoing data arithmetic operations.

Another interesting note is that all operations to any address register affect the entire address register. Because all MC68000 addresses are 32 bits wide, any operations with an address register as destination must perform in a way that keeps the result valid as a 32-bit address. One solution, to require all inputs to address-register operations to be full 32-bit quantities, would be wasteful of memory space. So either word (16-bit) or long-word (32-bit) operations may take place in any of the ad-

Instruction	Operation
ADD.B D6,D2	adds the lower 8 bits of D6 to D2 (takes 4 clock cycles)
ADD.L 52(A1,D7.W),D6	the effective address is the sum of the constant 52, the contents of register A1, and the lower 16 bits of register D7; the long word at the effective address is added to the contents of register D6 (20 clock cycles)
ADD.W D3,(A7)	adds the lower 16 bits of D3 to the element on top of stack pointed to by A7 (12 clock cycles)
ADDI.L #$400,D1	adds 400 hexadecimal to the 32-bit contents of D1 (16 clock cycles)
ADDI.B #$A9,$30B(A6)	the effective destination address is the sum of the 30B hexadecimal and the contents of register A6; A9 hexadecimal is added to the byte at the effective address (20 clock cycles)
ADDA.W −(A5),A2	decrement register A5 by 2, then add the word pointed to by register A5 to register A2 (14 clock cycles)
ADDA.W #100,A5	add the value 100 to the contents of register A5 (12 clock cycles)
ADDQ.W #1,(A4)+	add 1 to the word pointed to by register A4, then increment register A4 by 2 (12 clock cycles)
ADDQ.B #3,D7	add 3 to the contents of register D7 (4 clock cycles)
ADDX.L −(A2),−(A5)	after decrementing both registers A2 and A5 by 4, add together the X bit and the two long words pointed to by A2 and A5 (30 clock cycles)

Table 3: *Examples of MC68000 addition instructions. The clock times given are worst-case times for the instruction.*

dress registers A0 through A7. If a word operation is performed, the 16-bit quantity is first sign-extended to 32 bits before it is used.

Processor Speed

How fast does the MC68000 execute instructions? Because of the consistency of the microprocessor, the answer for addition instructions will serve as a guide for all arithmetic and logic instructions. A prefetching mechanism in the MC68000 keeps decoded instructions waiting to be executed. So while the timing information given refers only to the time it takes to pass through the adder, recall that the prefetcher will have fetched the next op code while the current op code is being executed.

The minimum time it takes the MC68000 microprocessor to access memory (to read or write) is 4 clock cycles. With a clock frequency of 8 MHz (the frequency used in the standard MC68000 microprocessor), this bus cycle will take 500 ns (nanoseconds). (All subsequent timings will be given in clock cycles, which is a meaningful measurement for all the MC68000-family microprocessors, regardless of the speed of their system clocks—8, 10, or 12.5 MHz.) Every instruction will take at least 4 clock cycles to complete because this is the time it takes to fetch the next op code.

The MC68000 has only one 16-bit arithmetic and logic unit (ALU) for data operations. Therefore, 8- or 16-bit operations can be performed in a single pass through this unit; this takes 4 clock cycles. A 32-bit operation will require a second pass. Memory-addressing modes increase the time needed for an operation because the microprocessor requires more time to calculate the addresses, and a bus cycle is required for each 16 bits of addressing information or actual data that needs to be transferred. An indexed addressing mode, or anything with a displacement, for instance, will require 1 additional bus cycle for the address extension word and another to get the data (2 if the data is a long word); add about 8 more clock cycles (12 if the data is a long word) to the execution time of a given instruction that uses this mode. Some sample worst-case clock timings for various addition instructions are given in table 3.

Like the ADD instruction, other MC68000 arithmetic instructions come in several forms. The subtract instructions have forms analogous to the add instructions—SUB, SUBA, SUBI, SUBQ, and SUBX. Instructions for compare operations that are all similar (CMP, CMPA, CMPI) perform the subtractions without storing a result (the net effect is to set the appropriate status register bits). A memory-compare instruction (CMPM) allows two strings of binary integers in memory to be compared by sequencing through them to higher memory. Two versions of the single-operand negate instruction, NEG and NEGX, ignore and include, respectively, the state of the X bit.

Multiplication and Division

Two versions of multiply and divide instructions make fast work of more complex arithmetic. The two versions are unsigned (MULU and DIVU) and signed (MULS and DIVS) instructions; these versions interpret their operands as one's-complement and two's-complement numbers, respectively. All of these instructions can include immediate values as the multiplier or divisor so that variables can be operated on by constants.

The multiply instructions take two 16-bit operands (one from any memory location by any addressing mode or any data register, and the other from the lower 16 bits of any data register), multiply them, and place the resulting product into the full 32 bits of the same data register. The divide instructions take the dividend from any 32-bit data register and divide it by a 16-bit divisor, which may come from memory using any addressing mode or any data register. The quotient is placed in the lower 16 bits of the same 32-bit data register, while the 16-bit remainder is placed in

Listing 1: *A short MC68000 assembly-language routine to multiply two 32-bit numbers.*

```
     Input:   register D0 contains 32-bit multiplicand
              register D1 contains 32-bit multiplier

     Output:  registers D0 and D1 contain the 64-bit result, with
               the most significant byte in D0

           SUBQ      #4,A7          initialize product area
           CLR.L     -(A7)
           MOVE.L    D0,-(A7)       save copy of multiplicand

           MULU      D1,D0          multiply low-order parts
           MOVE.L    D0,8(A7)

           MOVE.W    (A7),D0        high-order multiplicand
           MULU      D1,D0           times low-order multiplier
           ADD.L     D0,6(A7)

           SWAP      D1             now use high-order multiplier
           MOVE.W    2(A7),D0       low-order multiplicand
           MULU      D1,D0           times high-order multiplier
           ADD.L     D0,6(A7)
           BCC       MUL32A         carry into high-order
           ADDQ.W    #1,4(A7)       word of product

MUL32A     MOVE.L    (A7)+,D0       high-order muliplicand
           SWAP      D0
           MULU      D1,D0           times high-order multiplier
           ADD.L     (A7)+,D0
           ADDQ      #4,A7
           MOVE.L    (A7)+,D1       load low-order product
```

the upper 16 bits of the same register.

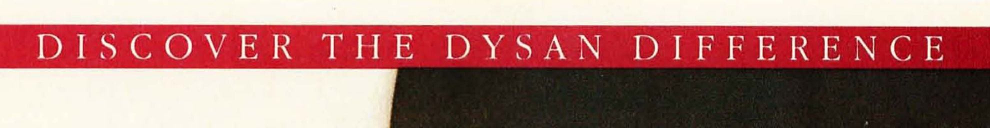
The divide instruction has two characteristics that may be undesirable and so are specially handled. All of us remember from high school and college that there just isn't any good way to divide by zero. The result is infinite if it's defined at all. Well, Motorola's designers didn't think they knew any better than the mathematicians, so if a zero divisor is detected, the divide instructions do not execute, and a special "trap" procedure is entered. Since the trap operation will be covered in part 3 of this article, let's just say that a "zero-divide trap" specially calls the operating system to decide what to do.

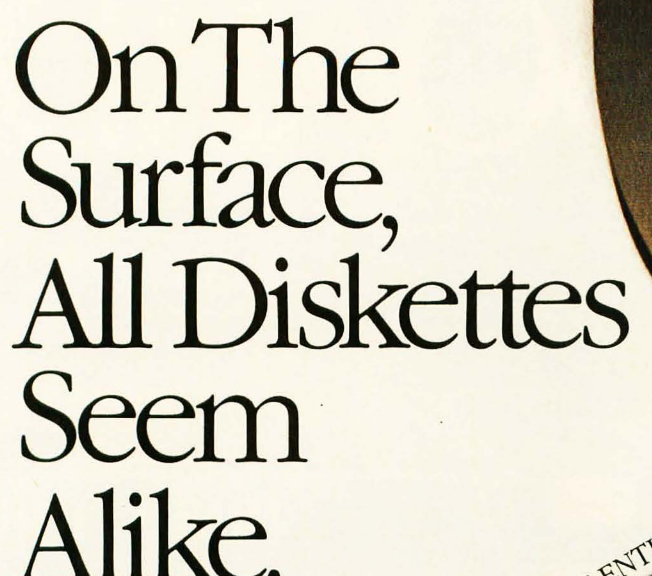
The other thing that could happen is that the divisor could be just too small for the dividend and the quotient could require more than 16 bits in which to be expressed. When this overflow condition is detected, the division is halted, the overflow (V) status register code bit is set, and the instruction is concluded without overwriting either of the original operands. Thus, following any divide instruction, you should check the overflow bit and act accordingly.

For a number of reasons, there are no instructions to multiply two 32-bit numbers or to divide a 64-bit number by a 32-bit number. First, the need for such instructions is very infrequent in most applications. Second, there are no other facilities in the machine to handle 64-bit quantities. Finally, because such instructions would take a lot of time to execute, the MC68000 would occasionally take much longer to respond to an interrupt—a situation the designers did not want to create.

The multiply instructions take fewer than 70 clock cycles to execute using register operands, and the divide instructions require fewer than 140 clock cycles for an unsigned operation (158 cycles for a signed operation); however, different combinations of 1s and 0s in the operands can make these operations take less than these times to execute. A short MC68000 routine that performs a 32-bit by 32-bit multiplication is shown in listing 1. It executes in about 60 microseconds, which is less time than that taken by the dedicated instruction that does the same thing in the Z8000.

Text continued on page 363





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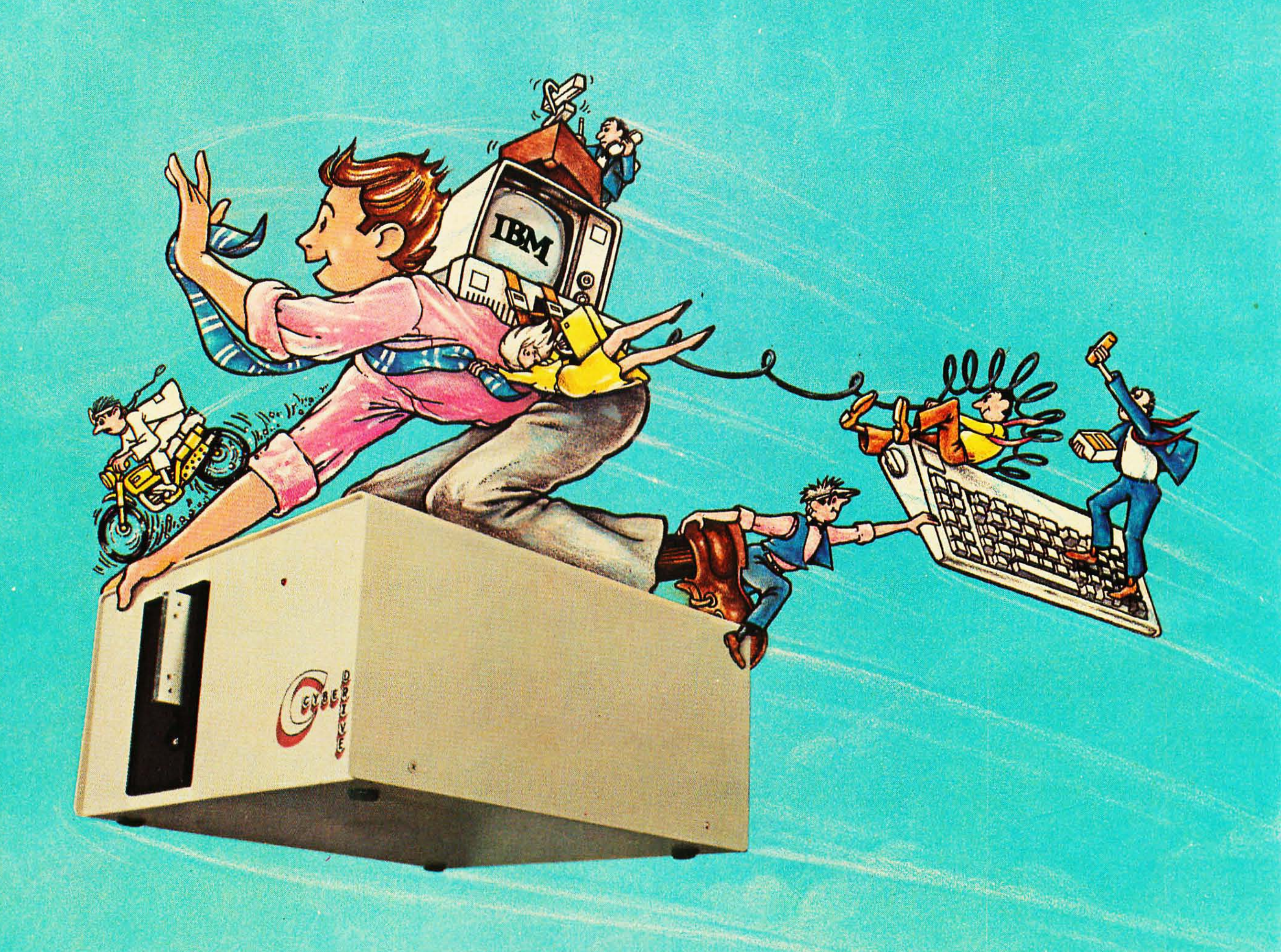
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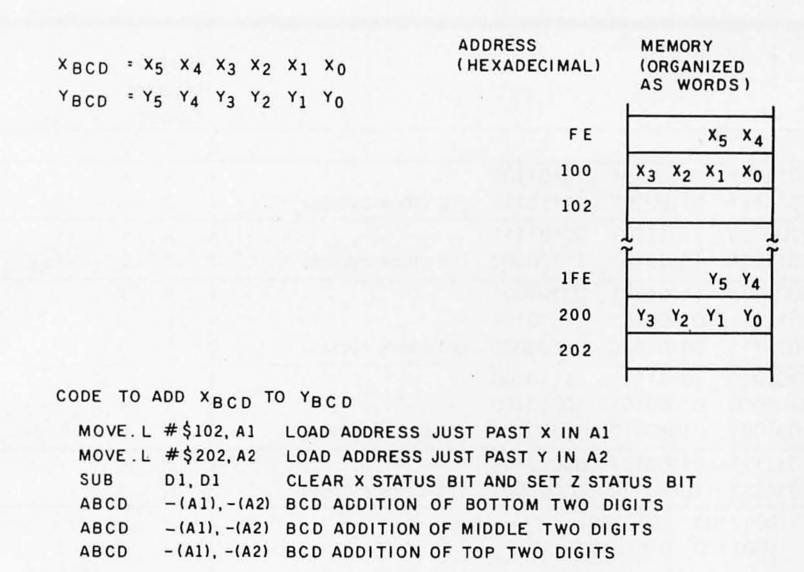


Figure 4: *An example of multiple-precision binany-coded decimal (BCD) arithmetic. Because the predecrement addressing mode used ("ABCD−(A1), −(A2)") decrements the register pointers before performing the BCD addition, registers A1 and A2 must be loaded with a value that points to the byte immediately after the least significant byte of the number to be worked on.*

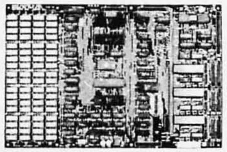
Binary-Coded Decimal Arithmetic

The final type of arithmetic instructions handles decimal digits. The most common form of human-interface data comes as *binary-coded decimal* or BCD data. This method of encoding numeric information as a string of bits stores each decimal digit of the number as a 4-bit binary number. Numbers are easily encoded into BCD form; once inside the computer, they are easily printable in human-readable form (much more so than numbers encoded in signed floating-point binary form). Because the BCD format is so useful, most microprocessors include instructions that operate on BCD numbers. To allow these BCD types of data to be manipulated, the MC68000 has three instructions that add (ABCD), subtract (SBCD), and negate (NBCD) packed digits. Each of these instructions works on two BCD digits packed into a byte.

Because BCD numbers may be many digits wide, the BCD instructions work as multiple-precision operations, which means they have the characteristics of the other multiple-precision instructions. The operands can be in data registers or in memory (in which case, they are operated on using the predecrement addressing mode). The value of the X status register code bit is included in the BCD operations, and the Z status register bit is handled so that it properly reflects the state of the entire result, not just the final portion.

Once again, the best thing about these instructions is the simplicity with which they operate, especially when compared with the often mysterious code a programmer had to write to do BCD arithmetic on most older microprocessors. A glance at MC68000 code performing BCD functions (see figure 4) shows how simple such code is. Here, two 6-digit numbers need to be added. While a short loop might make the routine more generally useful, inline code is fastest and illustrates the point best. First, we must load the two address registers to be used as memory pointers with the correct values. The next instruction (SUB D1,D1) is a quick way of both setting the Z bit and clearing the X bit, though a MOVE #$04,CCR would do virtually the same thing.

The three ABCD (add binary-coded-decimal) instructions begin at the least significant two digits and move toward the most significant;



Status Register Instruction	Register						Status Register Codes C	X	V
ASR.B #3,D3	(D3 before)	10111010	01011111	01100101	10101100		x	x	x
	(D3 after)	10111010	01011111	01100101	11110101	(12 clock cycles)	1	1	0
ASL.L #5,D1	(D1 before)	11101100	10100010	11011101	00101111		x	x	x
	(D1 after)	10010100	01011011	10100101	11100000	(18 clock cycles)	1	1	1
LSL.W D5,D7	(D5 before)	00101000	10001100	11101001	00101001		x	x	x
	(D7 before)	10111010	01011111	01100101	00010101		x	x	x
	(D7 after)	10111010	01011111	00101010	0000000	(24 clock cycles)	0	0	0
ROL.L D2,D1	(D2 before)	01100101	00101010	10111110	01110100		x	x	x
	(D1 before)	10010101	00101000	01000101	10010100		x	x	x
	(D1 after)	01011001	01001001	01010010	10000100	(48 clock cycles)	0	x	0
ROXR.W #4,D6	(D6 before)	10111010	01011111	01100101	00010101		x	P	x
	(D6 after)	10111010	01011111	101P0110	01010001	(14 clock cycles)	0	0	0
ROR $A0000	(word A0000 before)	10011100	10101001				x	x	x
	(word A0000 after)	11001110	01010100				1	x	0

Notes:

1. An "x" status-register bit may represent either a 0 or 1 value.
2. Notice that in the LSL.W and ROL.L examples the bottom six bits of the source operand (D5 and D2, respectively) are used as the number of bits to be shifted or rotated.
3. The "P" status-register bit in the "ROXR.W #4,D6" example is specially marked to show that it is shifted into the body of the D6 register as a result of the ROXR.W instruction. Note that .W causes only the bottom 16 bits of the register to be rotated.

Table 4: *Examples of shift and rotate instructions and their effect on registers and memory.*

this must be done to get accurate results from use of the extend bit. The result replaces the BCD number pointed to by A2; when the routine has finished, A2 points to the first byte of the BCD result (which is stored in order of most to least significant digit). Similar subtraction and negation operations can be built in the same way.

Logic Instructions

The MC68000 logic instructions are simple but powerful. The AND, OR, exclusive-or (EOR), and NOT instructions, like the arithmetic instructions, allow 8-, 16-, and 32-bit quantities in data registers or in memory to be operated on with any data register or an immediate constant, or to be inverted. These instructions are just as fast as the arithmetic instructions. Additionally, ANDI, ORI, and EORI instructions are used to clear, set, and toggle individual status register code bits.

A serial shifter in the MC68000 can be moved any number of bits to allow for shifting of 8-, 16-, and 32-bit data. The arithmetic-shift-right instruction (ASR) shifts the least significant bit to the X and C status bits while duplicating the most significant bit before moving it to the right. In the arithmetic shift left (ASL), the logical shift right (LSR), and the logical shift left (LSL), the bit shifted out of the data area goes into the X and C bits, while the bit into which no bit is being shifted is filled with a 0.

The rotate instructions shift bits around in a circular manner so that bits shifted out of one end of an operand are shifted in the other end, with the bit being shifted out of the data area also being copied into the C status register code bit and, optionally, the X bit. The rotate instructions are rotate right and rotate left (ROR and ROL); the ROXR and ROXL instructions are used when you want to update both the X and C bits.

One single shift or rotate instruction can move register data as many as 31 bit positions in the selected direction. You can specify this count value either statically (as a value between 1 and 8 encoded into the instruction op code) when the instruction is written or dynamically (as a value between 0 and 63 stored in a specified data register) when the instruction is executed. For simplicity, memory operands to be shifted or rotated are limited to displacements of 1 bit and operations on word-sized data only. Table 4 illustrates some shift and rotate instructions, their timing, and their effects.

An important aspect of programming that until the MC68000 was quite limited is that of individual bit manipulation, the ability to single out bits of memory, test them, set them, and clear them. Such operations are useful; in I/O, for instance, you frequently need to sense the state of a single input line, drive a particular output line high, or turn a servomechanism off. These operations involve only a single bit associated with a latch, peripheral, or memory location.

In the past, most of us have done the best we could by executing AND, OR, and EOR instructions to the desired location. But the difficulty with these operations is their crudeness. Sure, they allow us to change more than 1 bit at a time, but it turns out that much more secure code can be written when single events or conditions affect single outputs. Also,



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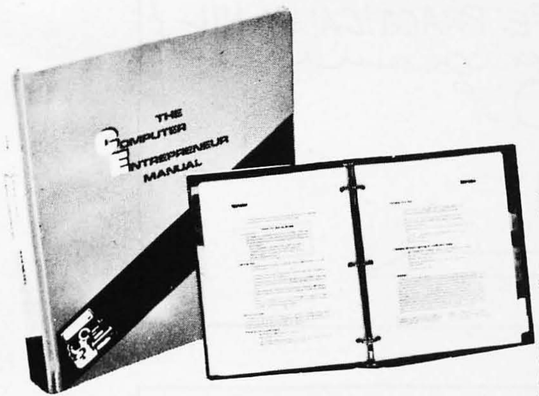
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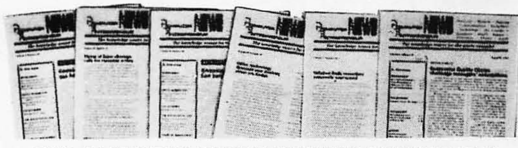
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because it is impossible to sense the state of more than one input at a time, nothing is gained by the ability of such instructions to work on multiple bits.

Four powerful MC68000 instructions make all bit-manipulation functions far simpler. They are the bit test (BTST), bit test and set (BSET), bit test and clear (BCLR), and bit test and change (BCHG) instructions. How will you specify the target bit? The MC68000 uses two methods, similar to those used for shift and rotate instructions. Either a data register or a series of bits in the bit-instruction op code names the bit to be affected; in this case, however, the bit number can be from 0 to 31 if a register is affected, or from 0 to 7 if the area affected is a memory location. (In the MC68000, bits in memory are identified by the bit number of the *byte* in which they reside.)

With true bit-manipulation instructions, not crude logic instructions, bit-manipulation operations—sensing the state of inputs, driving outputs, setting register bits, setting attribute bits, transposing bit matrices, or just building special data types—are straightforward tasks, not the chores they usually are with other microprocessors. The MC68000 makes it very easy to specify precisely the bit to be changed.

Conclusions

The computation and data-movement instructions that perform the major work in any MC68000 program are numerous, comprehensive, and, perhaps most important, straightforward and easy to use. The versatile MOVE instruction on the MC68000 replaces a confusing variety of data-movement instructions on other microprocessors. Flexible add, subtract, compare, negate, multiply, and divide instructions operate on any register, with constants, on stacks, and in memory using any addressing mode. For digital data rather than binary data, pairs of BCD numbers can be added, subtracted, and negated. The common logic operations of AND, OR, exclusive-or, and NOT can similarly operate on data registers and constants, and in memory.

When data needs to be shifted about, it can be arithmetic-shifted, logic-shifted, or rotated left or right. It can also be shifted or rotated multiple bit positions, with the count of the movement either predetermined and constant, or variable and dependent upon other data.

Individual bits in data or I/O can be separately tested to determine their state; they can also be set, reset, or toggled. The bit to be worked on can be chosen either when the instruction is written or, based on other data, when it is run.

All the above instructions can operate on 8-, 16-, or 32-bit data, with a uniform yet flexible set of addressing modes. This combination of good instruction set design, computational power, and ease of use make the MC68000 microprocessor an excellent one for assembly-language programming. Next month, I'll discuss program-control instructions and several advanced instruction groups.■

Building a Hard-Disk Interface for an S-100 System

Part 3: Software

How to alter the CP/M operating system so that it will accommodate a Winchester disk drive and controller.

Andrew C. Cruce and Scott A. Alexander
ASC Associates Inc.
POB 615
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In part 1 of this series we described Winchester disk technology in general and the benefits it would provide for microcomputer systems. We then gave an overview of the work that would be required to add such a disk to an existing computer system. In part 2 we discussed the rationale you should use in choosing a particular Winchester disk drive and disk controller (we decided on a Miniscribe disk drive and a Xebec controller). We then described in detail the construction of the hardware interface—the host computer adapter—required to integrate the disk drive into the S-100 system. In this last article of the series we will describe the final ingredient needed for our Winchester disk-drive subsystem: the software.

First we'll review the operation of the CP/M basic disk operating system (BDOS) and basic input/output system (BIOS) software. Specifically we will describe the process through which application programs use the BDOS to access disk file information and how the BDOS uses the BIOS to obtain specific information from a particular peripheral. This will highlight what has to be done to write a BIOS to handle the Winchester disk system.

Next we will describe the operation of the disk drive and controller as accessed through the host computer adapter (HCA). We'll show how disk commands are initiated from software and what commands are available from the disk controller. With this background out of the way, we will identify requirements for a Winchester disk-subsystem BIOS and how these requirements can be satisfied. We will then describe how a BIOS is structured and how the BIOS routines for the Winchester disk system can be included with the original system BIOS routines to support the other peripherals. Finally, we will briefly review the CP/M procedures required to include the combined BIOS in a new CP/M system.

This will essentially complete the integration process. However, we can improve system performance even further by putting the system's bootstrap routine on the Winchester disk. We'll describe how a bootstrap program operates and how you can develop a new bootstrap and install it on the Winchester disk drive. We'll also spend some time discussing various debugging techniques that will probably be very helpful when you integrate the hardware and software.

BDOS and BIOS

The CP/M operating system basically consists of two separate elements called the BDOS and the BIOS. The BDOS is supplied by Digital Research Inc. and is the essence of the CP/M operating system. In addition to the BDOS, however, the system requires a set of routines known as the BIOS to handle the hardware-peculiar functions of each peripheral in the system. These routines are usually supplied by the disk-drive manufacturer and must be modified by the user to include other system peripherals.

Accesses to disks and other peripherals by application programs are usually handled by calls to the BDOS. These calls are made by loading specified registers with information required by the BDOS and then performing a call to location 05. In the case of disk accesses you must load a function code into the C register and a pointer to the file control

About the Authors
Andrew Cruce has a Ph.D. in Aeronautical Engineering and has recently received an S.M. degree in management as a Sloan Fellow at MIT. Scott Alexander has an M.S. in Electrical Engineering. Both have extensive design and implementation experience with small computers and are full partners in the firm of ASC Associates, which markets the hardware described in this series of articles.

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BYTE	DESCRIPTION
00	POINTER TO SELECTED DISK
01 . . 08	FILE NAME
09 . 11	FILE TYPE
12	CURRENT EXTENT NUMBER OF FILE
13 14	RESERVED FOR SYSTEM USE
15	READ COUNT FOR EXTENT
16 . . 32	DISK ALLOCATION INFORMATION
33 . 35	OPTIONAL RANDOM RECORD NUMBER FOR DIRECT-ACCESS INPUT/OUTPUT

Figure 1: *A diagram of the file control block (FCB) format used by CP/M.*

block (FCB) of the desired file into the DE register pair. With this information, the BDOS determines what functions are to be performed and calls appropriate entry points in the BIOS with the information required to execute requested functions.

The BDOS disk functions are described in the standard CP/M documentation and include such functions as Open a File, Close a File, Read Next Record, and Write Next Record. The data structure that drives all these operations is the FCB, which is initially created by the application program and is updated by various BDOS functions. Figure 1 shows the structure of the FCB, which includes, among other things, the file name and file type along with 16 bytes of data that are used by CP/M in the calculation of a physical device address for access to the requested data. Additional data in the FCB is used to keep track of the drive the FCB is currently active on, a pointer to the current record, and a pointer to the current extent. If you are not familiar with the FCB construct, you can find additional information on it and the normal BDOS disk I/O functions in Digital Research's *CP/M Interface Guide*.

In order to understand the requirements for the Winchester disk BIOS, it is necessary to understand how this BIOS is used during the normal access of data from files contained on the Winchester disk. Figure 2 illustrates the steps that are performed in opening an existing disk file and reading the first 128 bytes of data from this file. This process is representative of the majority of the communications that occur between the BDOS and the BIOS during normal disk operations.

The process starts with the application program establishing which disk is to be active in the subsequent operations by loading the appropriate information in the C and E registers, as shown in the figure, and then calling the BDOS. The BDOS takes this information and passes it on to the BIOS, which then returns to the BDOS the address of a table that defines the physical characteristics of the disk that was selected. At this point, control is returned to the application program.

Next, the application program defines a DMA (direct memory access) buffer for subsequent disk operations by loading the DE register pair with the DMA buffer address, loading register C with 1A hexadecimal, and calling the BDOS. The BDOS in turn passes the DMA address to the BIOS for use in subsequent disk read/write operations.

After setting up the DMA buffer, the application program next opens the file that is to be read. First, the application program constructs an FCB for that file by reserving the required amount of space for the FCB, filling in the file-name and file-type portions of the FCB, and setting the Current Extent and Next Record fields to zero. The application program then calls the BDOS with the DE register pair pointing to the FCB and register C containing 0F hexadecimal. The BDOS must now search the file directory on the selected disk to determine if the file mentioned in the FCB is actually contained on the disk. In doing this the BDOS uses the BIOS to read each sector of the selected disk directory into memory and then searches for a match with the requested file name. When a match is found, the BDOS uses the information contained

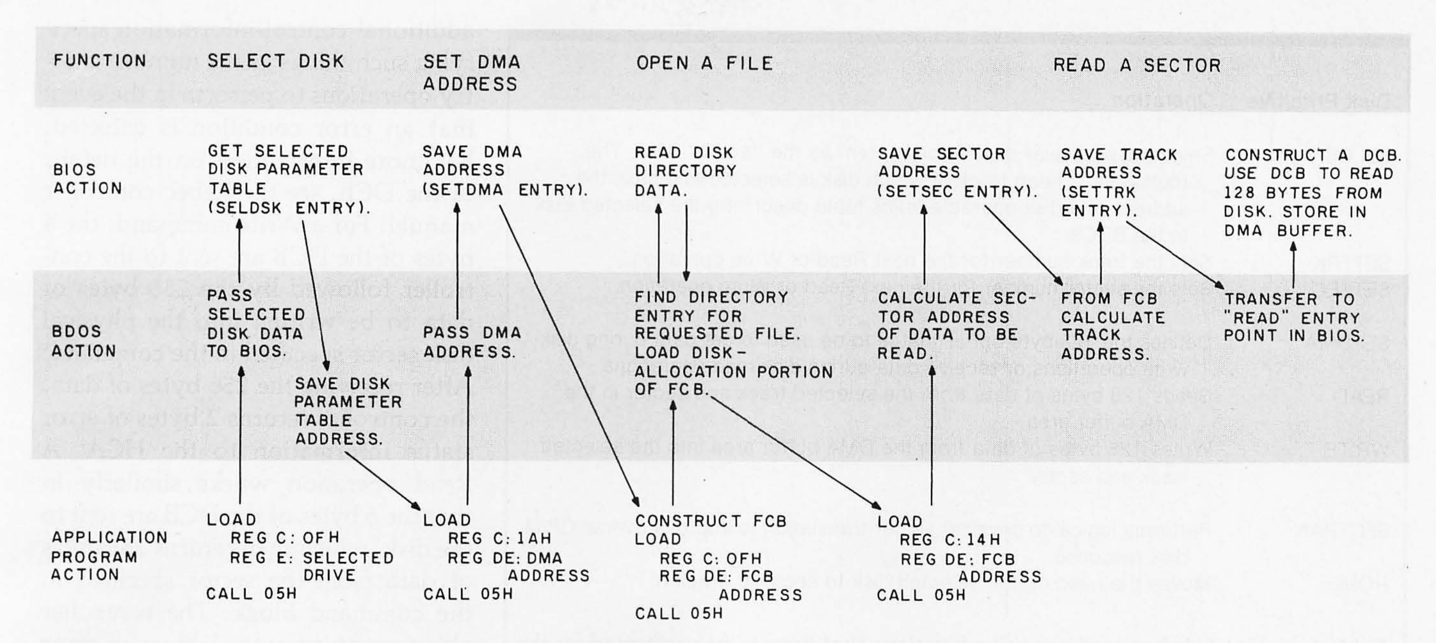


Figure 2: *A diagram of the input/output process for the Winchester disk subsystem.*

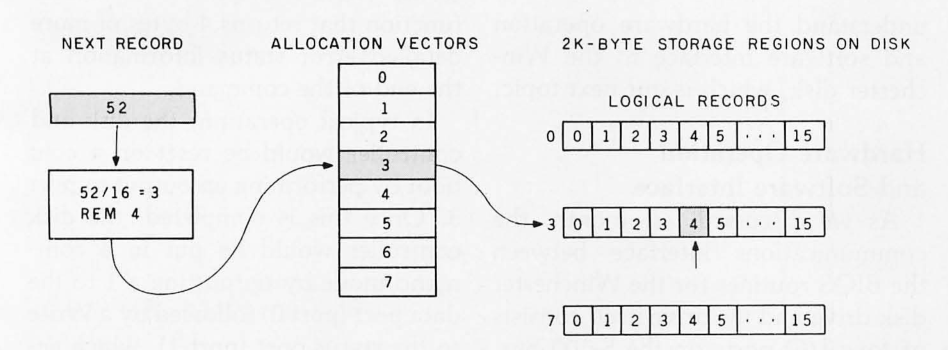


Figure 3: *A diagram showing how the Winchester disk address is calculated. First, the value of the Next Record field is divided by 16. The resulting quotient points to one of eight allocation vectors, which in turn points to one of several 2K-byte regions on the disk. The remainder of the division points to one of the 16 logical records in each 2K-byte region.*

in the directory entry to load the disk-allocation portion of the FCB. After filling in the required information in the FCB, the BDOS returns control to the application program.

The function of the disk-allocation portion of the FCB is to determine the physical disk address of particular records within a disk file. In the case of our Winchester disk system, the 16 bytes of disk-allocation information correspond to eight pointers, each containing 16 bits. These pointers refer to 2K-byte storage areas on the disk. Each of these 2K-byte storage areas is in turn made up of sixteen 128-byte logical sectors of disk information as required by CP/M. When a particular record is accessed, the value in the Next Record field of the FCB is divided by 16 to determine which disk-allocation vector to use in the disk-address calculation, and the remainder from this division is used to determine which logical sector in the storage region is required. This process is shown in more detail in Figure 3. It should be noted that a single file entry only provides access to 16K bytes on the disk. To access a larger file you must use extents, which are duplicate file entries containing unique pointers for different portions of the file.

The information derived from these calculations is used by the BDOS when the application program next issues the Read command to the BDOS. In this case the DE register pair is loaded with the address of the FCB, and register C is loaded with 14 hexadecimal when the BDOS is called. The BDOS then uses the data in the FCB to calculate a sector and track address for the requested data. First it passes the sector-address information to the BIOS (through the SETSEC entry point) followed by the track address information (through the SETTRK entry point). We'll discuss the design of the BIOS and the required entry points later. After the sector and track information have been passed, the BDOS then asks the BIOS to perform a Read operation of the identified sector.

At this point the BIOS takes the sector- and track-address information and constructs a device control block (DCB) that commands the Xebec controller to read the data from the requested sector of the disk. As we explained earlier in this series, the commands go from the computer, through the host computer adapter (HCA), to the disk controller. The disk controller then performs the requested Read operation from the disk, placing the data in a local memory area on the controller card. The BIOS can then begin to access the data being read from the disk and move it to the DMA memory buffer specified by the original SETDMA command. Once

Disk Primitive	Operation
SELDSK	Selects a particular disk in the system as the "active" disk. The routine must keep track of which disk is selected and pass the address of a disk-characteristics table describing the selected disk to the BDOS.
SETTRK	Sets the track number for the next Read or Write operation.
SETSEC	Sets the sector number for the next Read or Write operation.
SETDMA	Defines the 128-byte buffer that is to be used to get data during disk-write operations or receive data during disk-read operations.
READ	Reads 128 bytes of data from the selected track and sector in the DMA buffer area.
WRITE	Writes 128 bytes of data from the DMA buffer area into the selected track and sector.
SECTRAN	Performs logical-to-physical sector translation to improve overall CP/M disk response.
HOME	Moves the head on the selected disk to sector 0, track 0.

Table 1: *A list of disk-related primitive functions that have to be performed by the Winchester disk BIOS in order to be compatible with CP/M.*

all 128 bytes of the requested logical sector are moved into the DMA area, the Read operation is complete and control is returned to the application program.

In this overview of the combined operation of an application program, the BDOS, and the BIOS in accessing and reading information contained on the disk, some of the intricacies of the process, such as extents of disk files and detailed operation of the BDOS, have been glossed over. However, the illustration should provide enough information for you to understand the design and construction of a BIOS for a Winchester disk subsystem, and we refer you to CP/M documentation to gain a more in-depth understanding of the CP/M file control services (FCS) and the operation of the BDOS.

As you can see from the above example, only a few primitive functions have to be performed by a Winchester disk BIOS for it to be compatible with a CP/M system. Table 1 presents a complete list of these primitive functions along with a brief description of each function. In a complete BIOS, each of these functions is a separate entry point into the BIOS, and all you have to do to establish a BIOS is write code for each entry point to perform the necessary function. But first you must understand the hardware operation and software interface to the Winchester disk, which is our next topic.

Hardware Operation and Software Interface

As we discussed last month, the communications interface between the BIOS routines for the Winchester disk drive and the drive itself consists of four I/O ports on the S-100 bus. The addresses of these ports are selected in a contiguous block of four ports by switch settings on the HCA card. We will refer to ports 0 through 3 to indicate particular ports in this block.

Commands and data are sent to the controller by writing to these ports. The HCA retrieves data from the controller by reading from these ports. Each command to the controller consists of a block of 6 bytes of command information. This 6-byte block is the device control block mentioned earlier. Figure 4 shows the general format of the DCB and how this format is used for three different disk commands. The DCB always contains the op code and command types as shown in the general description of the data structure. In addition, the DCB may contain up to 21 bits of physical address information when an actual Read or Write operation is being performed. It also may contain additional control information specifying such things as the number of retry operations to perform in the event that an error condition is detected. For more information on the details of the DCB, see the Xebec controller manual. For a Write command, the 6 bytes of the DCB are sent to the controller followed by the 256 bytes of data to be written into the physical disk sector specified in the command. After receiving the 256 bytes of data, the controller returns 2 bytes of error status information to the HCA. A Read operation works similarly in that the 6 bytes of the DCB are sent to the disk, which then returns 256 bytes of data from the sector specified in the command block. The controller also tags on an extra 2 bytes of error status information at the end of the transfer. In addition, the Xebec controller offers a Request Sense Status function that returns 4 bytes of more detailed error status information at the end of the command.

In typical operation, the disk and controller would be reset on a cold boot by performing an output to port 3. Once this is completed, the disk controller would be put in a command mode by outputting a 1 to the data port (port 0) followed by a Write to the status port (port 1), which activates the SEL signal. (This and many of the signals referred to in this section were described last month.) The disk-access routine then examines the REQ line by performing an input from port 1 and testing the proper status line. When the REQ line becomes active the routine outputs the first of the 6 command bytes to port 0. This output automatically generates the ACK signal to complete the handshake between the HCA and the controller. The software then monitors the REQ line until it again becomes active and then sends the second command byte. This process is repeated until all 6 command bytes have been sent to the disk controller. The routine then uses the same process to read or write the appropriate number of data bytes at port 0 depending on the particular command that was sent. In the case of a BIOS routine, the disk address that is to be accessed is derived by the BDOS from

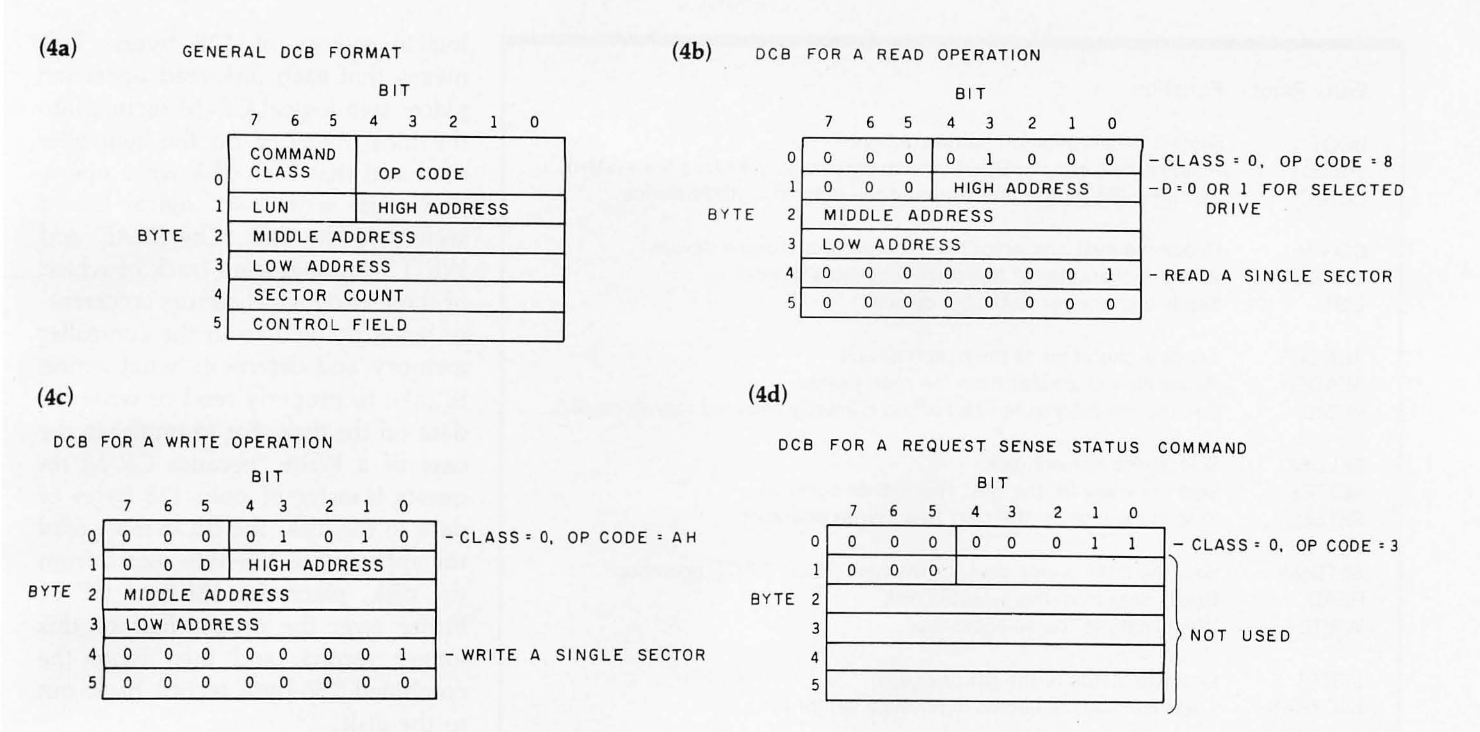


Figure 4: *The device control block (DCB) used by the Xebec hard-disk controller. Figure 4a shows the general format for the DCB. Figures 4b through 4d show how the DCB is used for a Read operation, a Write operation, and a Request Sense Status command, respectively. Byte 0 contains information on the Command Class and the Op Code. LUN (logical unit number) indicates which drive you have selected of the two possible drives that can be connected to the controller. The high, middle, and low addresses form a 21-bit physical sector address. Byte 4 indicates the number of sectors to be read or written (for CP/M this is always 1). Byte 5 contains the following control fields: bit 7, when set, disables the four re-tries by the controller on all disk-access commands (during normal use, this is always 0); bits 3 through 6 are not yet used and are set to 0; and bits 0 through 2 select half-step options for other disk drives (for the Miniscribe drive, this is set to 0).*

the information contained in the FCB. This information is then passed to the BIOS routines at the SETTRK and SETSEC entry points and the BIOS uses this information to construct the DCB for the actual disk access.

Generating a Combined BIOS

The BIOS structure is very simple. A table of jump vectors is placed at the beginning of the BIOS code. This includes jumps to each of the primitive functions that the BIOS performs. Table 2 shows that these functions include the disk-oriented primitives presented in more detail in table 1 as well as the necessary functions to handle the other peripherals in the system, such as terminals and printers. The BIOS routines for peripherals other than disks are used without modification in the construction of a new combined BIOS. The existing disk and boot functions are augmented as shown in figure 5. The cold boot functions for both the existing disk system and the new Winchester disk are combined to ensure that all peripherals on the system are properly initialized when the system is booted. A new SELDSK function is written that keeps track of which disk system is selected and passes the proper disk-definition-table address back to the BDOS. Finally, a series of disk-handling routines are written for the Winchester disk. These routines are used as the initial vector addresses for the initial jump table. Depending on the particular entry point, these routines either perform the indicated function for the Winchester drive and then transfer to the appropriate function for the existing floppy drive or test to see which drive is selected and simply transfer control to the appropriate routine for the selected drive. An example of the first case is the SETDMA function, which causes the DMA buffer address to be set for both the Winchester and any other disk drives in the system. In the case of an actual READ function, however, a test is made for the selected disk and then control is passed to the proper disk-read routine. Listing 1 on page 386 presents a skeleton of a combined BIOS that includes all the BIOS routines for the Winchester disk drive and comments indicating where routines from an existing BIOS should be placed.

The code presented in listing 1 has been tested and will operate with a Xebec controller connected to a Miniscribe disk using the HCA described in last month's article. The SELDSK entry point keeps track of which disk is selected and uses register pair HL to pass the address pointer of the selected disk characteristics table to the BDOS. This table is located at DPBASE in the BIOS code and has been created using two macros, DISKS and DISKDEF, supplied by Digital Research. These macros and the structure of this table are described in Digital Research's *CP/M System Alteration Guide.* The code for the cold boot entry point, BOOT, assumes that a new copy of the sys-

Entry Point	Function
BOOT	System initialization on hardware boot.
WBOOT	Reads a new copy of BDOS into memory and initializes the system.
CONST	Samples and returns the status of the current console device.
CONIN	Reads the next character from the current console device.
CONOUT	Writes a character to the current console device.
LIST	Sends a character to the list device.
PUNCH	Sends a character to the punch device.
READER	Reads next character from the read device.
HOME	Returns the read/write head of the currently selected disk to track 0.
SELDSK	Selects the current disk.
SETTRK	Sets the track for the next Read/Write operation.
SETSEC	Sets the sector for the next Read/Write operation.
SETDMA	Sets the DMA buffer area for the next READ/WRITE operation.
READ	Reads data from the selected disk.
WRITE	Writes data to the selected disk.
LISTST	Gets the status of the list device.
SECTRAN	Translates logical sector to physical sector.

Table 2: *A complete list of primitive functions for the BIOS in CP/M. Note that this includes the disk-related primitives in table 1.*

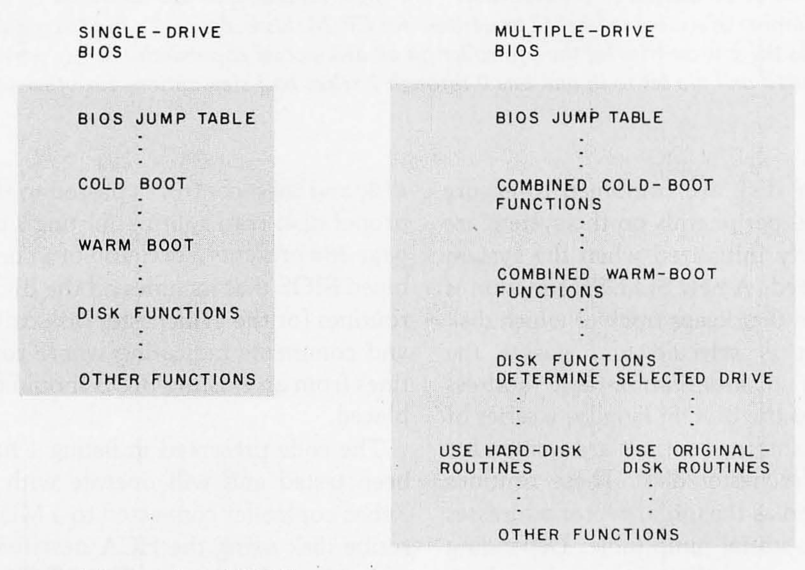


Figure 5: *The combined BIOS structure.*

tem has already been booted into memory and simply performs any required initialization before transferring control to CP/M. The warm boot, WBOOT, reloads a new copy of the BDOS and the console control program (CCP) before transferring control back to CP/M. The HOME, SETTRK, SETSEC, and SETDMA entry points perform the commanded function for both the Winchester disk system and for the existing disk system. Finally, the READ and WRITE entry points determine which disk is currently selected and transfer control to the appropriate routines to read or write data from or to the selected disk.

Another complication concerning Read and Write operations on the Winchester disk drive arises from the fact that the Winchester disk is set up to read and write 256-byte physical sectors, whereas CP/M operates in logical sectors of 128 bytes. This means that each disk-read operation places two logical CP/M sectors into the local memory on the controller card and that each disk-write operation must write two logical CP/M sectors to the disk. The READ and WRITE routines keep track of which of these two logical sectors is currently being pointed to in the controller memory and determine what action to take to properly read or write the data on the disk. For example, in the case of a Write, because CP/M requests transfer of only 128 bytes of data to the disk, the BIOS must read the appropriate 256-byte record from the disk, place the 128-byte CP/M buffer over the proper *half of this* longer record, and then write the combined 256-byte record back out to the disk.

Additional Utilities

Two other software utilities must also be written prior to completing the installation of the hard-disk system. The first of these is a formatting utility that will format the disk and check for any bad tracks on the disk. The second is a system-generation utility that will write the new operating system beginning at track 0, sector 0 on the Winchester disk after the combined BIOS has been integrated into a CP/M system. This last process places a hardware-bootable system on the hard disk.

A new Winchester disk drive is delivered in an unformatted condition. This means that the disk has no information identifying the beginning and end of each sector. Once the HCA and other disk hardware is integrated into the system, you must create a routine to write this formatting information on the disk. A formatting routine is then used to issue a DCB to the controller, commanding it to format the disk. The controller takes care of the rest by writing the required formatting information onto the disk.

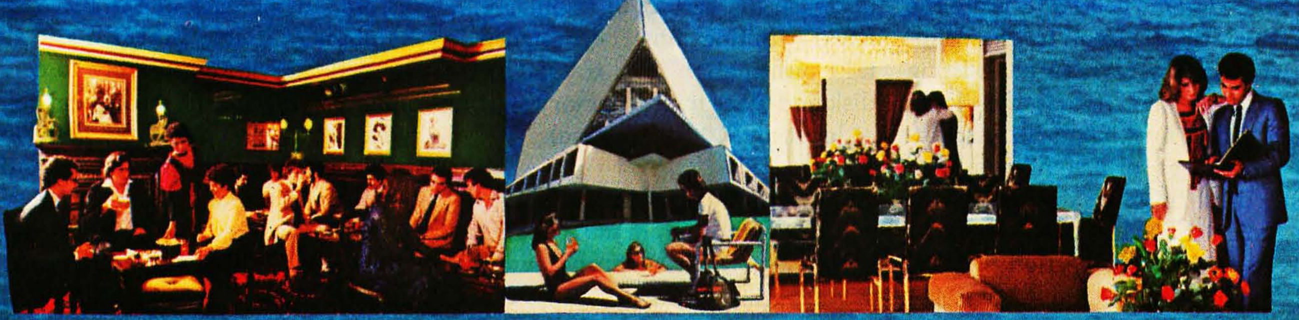
When the disk formatting is complete, the formatting routine should then read each sector on the disk to determine if the drive hardware was delivered with any bad sectors on the disk. For Winchester disk drives, it is

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not uncommon for a disk to have several bad sectors. The test program reads all sectors on the disk and saves the location of any bad sectors identified during the Read process. The routine then identifies these bad sectors to the controller, which constructs an alternate track assignment for each of the bad sectors on the disk. After this alternate assignment is complete, the existence of bad sectors on the disk is transparent to the system. The controller keeps the alternate-track data on the disk and, when a disk access is made to a bad sector, the controller automatically switches to the alternate track to read or write the data.

The second utility, the system-generation program, is used to write the new operating system to the Winchester drive or to read an existing operating system from the Winchester drive into memory. Installation procedures for a combined Winchester drive BIOS are the same as for any typical CP/M BIOS and will be covered in the next section. At the end of the configuration process, a system image will reside in memory starting at location 900 hexadecimal. The locations 900 to 980 hexadecimal contain the system loader, and the locations from 980 hexadecimal on contain the newly configured operating system. A WRITE routine must be designed to take the data from these locations in memory and write them to the Winchester disk drive starting at track 0, sector 0. Similarly, a READ routine must be designed to take information from track 0 of the disk and place it into memory starting at location 900 hexadecimal.

No matter how careful you are in building the system, something is bound to be wrong.

Building a New BIOS

One other program must be written before a new BIOS can be built and installed in a CP/M system. This is the system loader that is used to initially read in the system from the disk. This program is written to run at location 80 hexadecimal and is restricted to 128 bytes in length. It is used to load the system during the bootstrap process that we will describe later. The program is designed to read the system starting at track 0, sector 1 of the Winchester disk and, when the load is complete, to transfer control to the proper entry point of CP/M to start the operating system running.

Once the system loader and the BIOS code are complete, the next step is to assemble both of these programs and remove any assembly or syntax errors. In the case of the BIOS, the symbolic variable MSIZE must also be defined before assembly to correspond to the size of the system being generated. Assuming that you have achieved an error-free assembly, the next step is to build a new CP/M system that contains the new system loader and BIOS and to write this

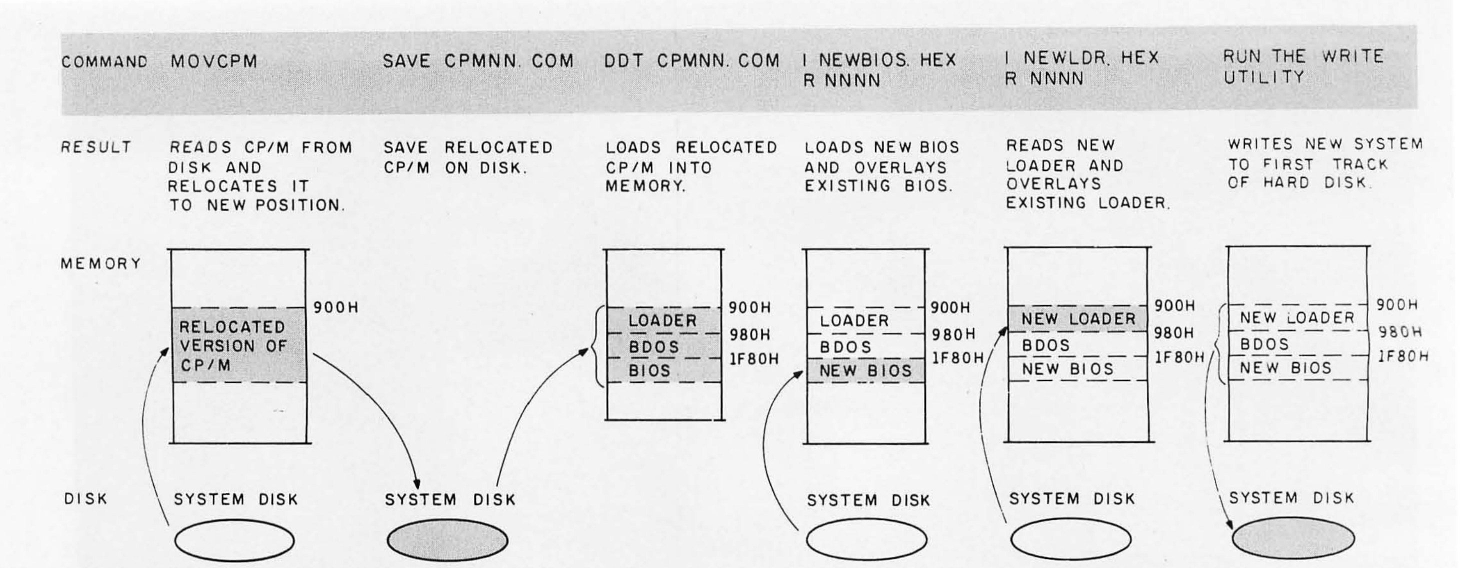


Figure 6: *Installing the new operating system. First, the MOVCPM instruction reads the current version of CP/M from the disk into memory at location 900 hexadecimal and relocates it to run at a location specified in the command. The SAVE instruction then places the relocated version of CP/M onto the disk under the filename CPMNN.COM. The DDT command reloads the relocated version of CP/M into memory at location 900 hexadecimal and transfers control to the DDT program. Next, the command I NEWBIOS.HEX reads the new BIOS from the disk and overlays the existing BIOS. The command I NEWLDR.HEX then reads the new system loader from the disk and overlays the existing loader. Finally, the WRITE utility program writes the properly configured operating system to the first track of the Winchester disk.*

new system to the Winchester disk drive starting at track 0, sector 0. In this process you should first use the MOVCPM utility (provided by CP/M) to create a new copy of CP/M that is properly sized for the system. Then, as instructed in the MOVCPM utility, this new copy of the operating system must be saved on the disk for later retrieval by using CP/M's standard SAVE utility. Once the new copy of the system is saved, the next

step is to read the system back into memory using the DDT utility. If the system was saved under the name CPMNN.COM you can use the following CP/M command to initiate DDT and read the new copy of the system into memory:

DDT CPMNN.COM

After this command is executed, the new system will be located in memory starting at location 900 hexadecimal, and DDT will be running. The next step is to overlay the new system loader and new BIOS on top of the copy of CP/M in memory by using two DDT commands: I (insert) and R (read). These commands place the new system loader into memory at location 900 hexadecimal and place the BIOS at location 1F80 hexadecimal. Once these overlays are complete, the system is properly configured for the Winchester disk drive. Next we must get out of DDT and return to CP/M while leaving the newly created copy of the system in memory. First, issue a G0 command to DDT that transfers control to CP/M. Once you are back in CP/M, the final remaining task is to run the system-generation utility to load the newly constructed system, which now resides in memory starting at location 900 hexadecimal, onto the Winchester disk starting at track 0, sector 0. Figure 6 graphically summarizes these steps.

Building a New Bootstrap

At the completion of the process we just described, a copy of a properly configured CP/M system and system loader is on the first track of the Winchester disk. The one remaining task is to develop the software to bootstrap this system into memory and to configure the hardware so that this bootstrap is executed when a hardware boot command occurs. The actual bootstrap code is very simple. All it has to do is read the first 128 bytes from track 0, sector 0 on the Winchester disk drive into memory starting at location 80 hexadecimal and, when the read is complete, transfer control to the beginning of this code. This bootstrap code should be written to run at whatever location is going to be assigned to the PROM (programmable read-only memory) chip on the HCA, which we mentioned last month. When properly assembled and linked, the bootstrap code is burned into the HCA PROM and the software installation is essentially complete. The processor board is then "restrapped" so that the bootstrap address corresponds to the beginning of the PROM on the HCA.

Once this modification has been completed, a hardware boot command (i.e., pressing the RESET button) results in the sequence of events presented in Figure 7. At the boot command, the processor begins executing code at the beginning of the HCA PROM. This code reads the first 128 bytes of data from the first physical sector of the first track on the disk into memory starting at location 80 hexadecimal. When the read is complete, the code in the PROM

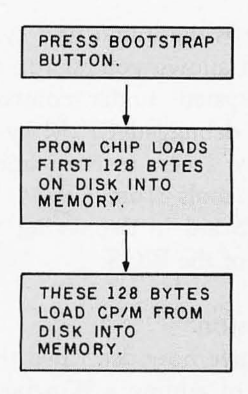
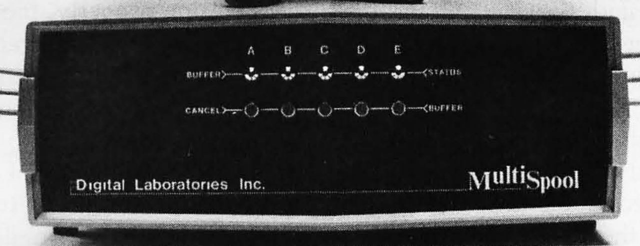


Figure 7: *The Bootstrap process. Pressing the hardware bootstrap (Reset) button causes the microprocessor to transfer control to the PROM chip on the host computer adapter. The code in the PROM reads the first 128 bytes of data from track 0 of the hard disk into memory starting at location 80 hexadecimal and then transfers control to that location. This code in turn loads the CP/M system off the first track of the Winchester disk. Then, when the load is complete, the code transfers control to location 0 hexadecimal to start CP/M running.*

transfers control to location 80 hexadecimal, which now contains the system loader. This code now reads the remainder of the CP/M system from the first track on the disk into memory and then transfers control to the CP/M system. The result is that a properly configured system, which includes the Winchester disk drive, is left running in memory, waiting to respond to any user commands.

System Debugging

No matter how careful you are in building the hardware and software we have just finished describing, it is a fact of life that when plugged into the system there will be something wrong. This is when the really interesting portion of the system integration process begins, namely, finding and correcting the inevitable bugs in the hardware and software. This debugging process can be broken into three separate areas. The first is debugging the HCA. The second is debugging and examining the HCA, disk controller, and disk system. The last is debugging the CP/M interface software. We will now describe some of the techniques that can be used in each of these areas.







The first thing to debug is the HCA card. Debugging this device involves making sure that the various combinations of possible input conditions result in the expected outputs to the disk controller. You can do this most efficiently by writing a set of driver routines in assembly language to write messages to the various output ports on the HCA. If you write these routines to loop continuously, you can use an oscilloscope to check the output registers on the HCA to ensure that the card is acting properly.

When you've verified proper operation of the HCA to the maximum extent possible, next connect the disk controller and the Winchester disk drive to the HCA. This simple connection begins the debugging process for the Miniscribe disk drive, which has extensive self-test features and continuously monitors its own operation to check for faults. If a fault is detected, the drive communicates with the user by flashing a Morse code letter (using the drive select light) to identify the particular fault that was detected. Once the disk is operating properly, the way to debug and test the rest of this total system is to pass various DCBs to the disk controller and see if the disk responds to these DCB inputs as expected. For example, you can test the disk by performing a controller self-test, formatting the disk, writing information to a particular sector, reading the information back, and testing for error conditions. This type of testing not only verifies proper disk operation but also provides you with valuable insight into the disk operation, which you can use during the remainder of the integration process.

Once the disk subsystem hardware is operating properly, the next step is to integrate the software. We described this integration process earlier. However, during the initial testing it is convenient to modify this procedure to allow use of some of the CP/M debugging tools to debug the interface software. To do this, you should create a "false" CP/M system that runs inside (i.e., at a lower memory address than) the current CP/M system running on the computer. This keeps the initial user system intact and allows you to run the new CP/M system under control of an existing debugged CP/M system, so you have access to the standard debugging tools from CP/M, such as DDT, to aid in debugging the new version of the BIOS.

Conclusion

We have now described the entire process of adding a Winchester disk subsystem to an S-100 computer system running CP/M. As we have tried to show, this is a rather substantial undertaking and should not be started lightly. The main advantage in performing such an integration project is the learning that takes place during the project. If your main goal is to obtain additional storage capability for a microcomputer, you could obtain this storage less expensively and certainly with less effort by buying a commercially available unit such as the one we manufacture. Because of quantity pricing and volume discounts, complete Winchester disk-drive subsystems are commercially available at a cost comparable to what a hobbyist would spend for the hardware portion of the system alone.

However, if you are interested in doing the work yourself and you have the necessary time and expertise, we encourage you to attempt this project and use this series of articles as a guide. ■

The Winchester disk drive subsystem described in this series of articles is available as a completely assembled unit from ASC Associates of Lexington Park, Maryland. In addition to the S-100 version discussed, versions are also available for TRS-80 and Apple computers. The disk-drive systems for these computers use the same drive and controller hardware as the S-100 version but use a different host computer adapter and interface software. Until a nationwide dealer distribution network is established, these systems will be available by mail order for $1995. To order or obtain further information, write to ASC Associates Inc., POB 615, Lexington Park, MD 20653, or phone (301) 863-6784.

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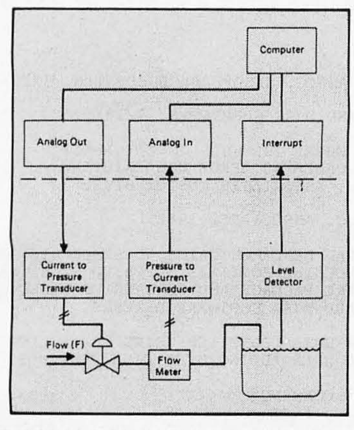
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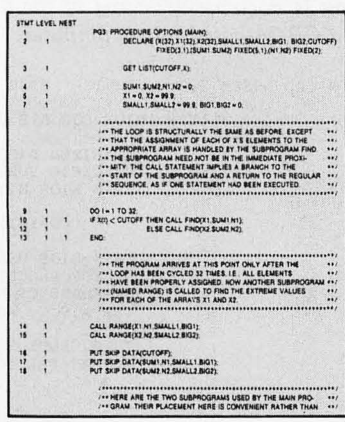
The Encyclopedia gives you information on:



SPECIAL PURPOSE COMPUTERS

You'll see how computers can be designed and constructed to serve specific application purposes. There's information on configuration special-purpose machines... industrial control computers directly connected to physical processes, along with an indication of the specialized subsystems they require... analog input... ultra-high availability computers, such as NASA's computer interconnection for the Space Shuttle.

There's also a look at pipeline and array processors... computational special-purpose computers... vector processors versus scalar processors ... algorithmic processors... parallel processors... associative processors ... plus a look at the future of special-purpose architecture and the cost justifications for these large, specialized machines.



```
STMT LEVEL NEST
  1              PG3: PROCEDURE OPTIONS (MAIN);
  2    1               DECLARE (X(32),X1(32),X2(32),SMALL1,SMALL2,BIG1, BIG2,CUTOFF)
                             FIXED(3,1),(SUM1,SUM2) FIXED(5,1),(N1,N2) FIXED(2);

  3    1               GET LIST(CUTOFF,X);

  4    1               SUM1,SUM2,N1,N2 = 0;
  5    1               X1 = 0; X2 = 99.9;
  7    1               SMALL1,SMALL2 = 99.9; BIG1,BIG2 = 0;

            /************************************************************/
            /** THE LOOP IS STRUCTURALLY THE SAME AS BEFORE, EXCEPT    **/
            /** THAT THE ASSIGNMENT OF EACH OF X'S ELEMENTS TO THE     **/
            /** APPROPRIATE ARRAY IS HANDLED BY THE SUBPROGRAM FIND.   **/
            /** THE SUBPROGRAM NEED NOT BE IN THE IMMEDIATE PROXI-     **/
            /** MITY. THE CALL STATEMENT IMPLIES A BRANCH TO THE       **/
            /** START OF THE SUBPROGRAM AND A RETURN TO THE REGULAR    **/
            /** SEQUENCE, AS IF ONE STATEMENT HAD BEEN EXECUTED.       **/
            /************************************************************/

  9    1         DO I = 1 TO 32;
 10    1    1    IF X(I) < CUTOFF THEN CALL FIND(X1,SUM1,N1);
 12    1                        ELSE CALL FIND(X2,SUM2,N2);
 13    1    1    END;

            /************************************************************/
            /** THE PROGRAM ARRIVES AT THIS POINT ONLY AFTER THE       **/
            /** LOOP HAS BEEN CYCLED 32 TIMES, I.E., ALL ELEMENTS      **/
            /** HAVE BEEN PROPERLY ASSIGNED. NOW ANOTHER SUBPROGRAM    **/
            /** (NAMED RANGE) IS CALLED TO FIND THE EXTREME VALUES     **/
            /** FOR EACH OF THE ARRAYS X1 AND X2.                      **/
            /************************************************************/

 14    1         CALL RANGE(X1,N1,SMALL1,BIG1);
 15    1         CALL RANGE(X2,N2,SMALL2,BIG2);

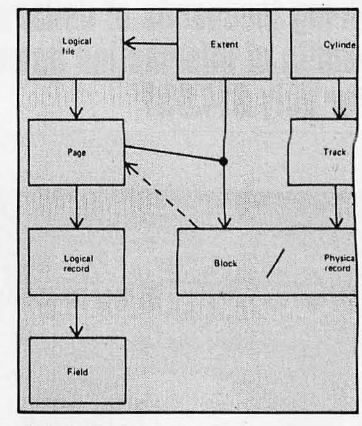
 16    1         PUT SKIP DATA(CUTOFF);
 17    1         PUT SKIP DATA(SUM1,N1,SMALL1,BIG1);
 18    1         PUT SKIP DATA(SUM2,N2,SMALL2,BIG2);

            /************************************************************/
            /** HERE ARE THE TWO SUBPROGRAMS USED BY THE MAIN PRO-     **/
            /** GRAM. THEIR PLACEMENT HERE IS CONVENIENT RATHER THAN   **/
```

PROCEDURE-ORIENTED LANGUAGES

The ENCYCLOPEDIA offers an in-depth look at both the advantages and drawbacks of procedure-oriented languages. There are discussions of compilers. Program transportability from computer to computer. Programming styles and techniques. Modular construction of programs. Subroutine handling. Tracing. Decisions and decision structures.

Furthermore, there are overviews of the major procedure-oriented languages in use today, including FORTRAN... COBOL, with an example, ... ALGOL... PASCAL... PL/1... BASIC ... and APL. In addition, there is a discussion of the future of procedure-oriented languages and a look at the new languages that are being developed for future use.

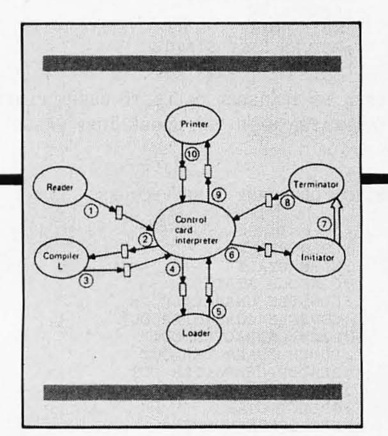


SMALL COMPUTERS

Q. Where can you find a concise overview of the booming small computer field?

A. The Encyclopedia shows you how microcomputers developed and how they may become even more powerful in the future. There are details on personal computing software packages and how new applications can be developed on small computers—including coverage of everything from financial software to speech synthesis to computer games.

Also spelled out are the basic functional units of a microcomputer... storage techniques such as bubble memory and magnetic diskettes... the use and application of microcomputers in controlling industrial processes... the small computer as an intelligent terminal... and much more.



OPERATING SYSTEMS

The Encyclopedia introduces a survey article on the features and functions of operating systems. You'll find fingertip access to details on CPU's, memory, and peripheral devices... I/O buffering, library routines, file handling, system logging... multiprogramming... memory protection and relocatability ... spooling and off-line processes.

Further topics covered include: an overview of commercially-available systems... system types [dedicated transaction, interactive, extensible]... multitask capabilities... interrupt-based systems... task dispatching and control... file storage... distributed operating systems... and more.

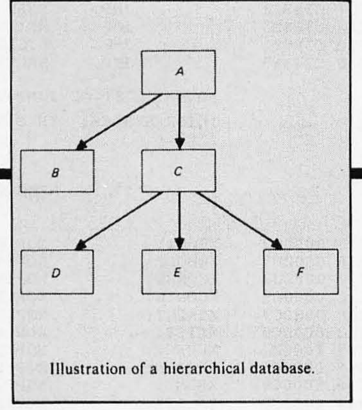


Illustration of a hierarchical database.

DATABASE MANAGEMENT

The Encyclopedia examines database concepts... record types and their physical and logical relationships... structure diagrams... and optional relationships. You'll find coverage of generalized database management system [DBMS] software... network, hierarchical, and relational databases ... how DBMS facilities are provided... and ways in which designers can integrate separate applications in one database.

Further articles examine the role of the database administrator... the design and construction of distributed databases which support computer networks... on-line database organization... new advances in database technology... and much more.

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Listing 1: *A complete listing of the BIOS needed to integrate a Winchester disk drive into a CP/M-based microcomputer.*

```
CP/M MACRO ASSEM 2.0     #001     BIOS FOR A.S.C. ASSOC. HARD DISK SUBSYSTEM. 7/18/82

                         TITLE 'BIOS FOR A.S.C. ASSOC. HARD DISK SUBSYSTEM. 7/18/82'
                         ;
                         ;        COMBINED BIOS INDICATES WHERE THE USER IS TO UPDATE
                         ;        SPECIFIC SUBROUTINES IN ORDER TO MERGE HIS EXISTING
                         ;        CP/M BIOS WITH THE A.S.C. ASSOCIATES CUSTOM BIOS.
                         ;
                         ;              COPYRIGHT (C) A.S.C. ASSOCIATES 1982
                         ;
                         ;        THIS BIOS USES THE DIGITAL RESEARCH CBIOS, DISKDEF LIB, AND
                         ;        SECTOR BLOCKING AND DEBLOCKING ROUTINES SUPPLIED WITH THE
                         ;        STANDARD CP/M 2.2 SOFTWARE PACKAGE AND IS THEN COMBINED WITH
                         ;        THE A.S.C. ASSOCIATES HARD DISK SOFTWARE DRIVERS.
                         ;
                         ;        THROUGHOUT THIS CODE COMMENTS DELIMITED USING THE FOLLOWING
                         ;        FORMAT ARE TO BE CHANGED WHEN ADDING USER DISK ROUTINES.
                         ;
                         ;                  >>>>>  COMMENT  <<<<<
                         ;
                         ;
003A =                   MSIZE    EQU      58       ;CP/M VERSION MEMORY SIZE IN KILOBYTES
                         ;
                         ;
9800 =                   BIAS     EQU      (MSIZE-20)*1024
CC00 =                   CCP      EQU      3400H+BIAS          ;BASE OC CCP
D406 =                   BDOS     EQU      CCP+806H          ;BASE OF BDOS
E200 =                   BIOS     EQU      CCP+1600H         ;BASE OF BIOS
0004 =                   CDISK    EQU      0004H             ;CURRENT DISK NUMBER 0=A,...,15=P
0003 =                   IOBYTE   EQU      0003H             ;INTEL I/O BYTE
0001 =                   NUDISKS  EQU      1                 ;NUMBER OF DISKS IN SYSTEM
                         ;
                         ;
E200                              ORG      BIOS              ;ORGIN OF THIS PROGRAM
                         ;
002C =                   NSECTS   EQU      (BIOS-CCP)/128    ;WARM START SECTOR COUNT
                         ;
                         ;
                         ;        JUMP VECTOR FOR INDIVIDUAL SUBROUTINES
E200 C385E2                       JMP      BOOT              ;COLD START
E203 C394E2              WBOOTE:  JMP      WBOOT             ;WARM START
E206 C3F3E2                       JMP      CONST             ;CONSOLE STATUS
E209 C3F6E2                       JMP      CONIN             ;CONSOLE CHARACTER IN
E20C C3F9E2                       JMP      CONOUT            ;CONSOLE CHARACTER OUT
E20F C3FCE2                       JMP      LIST              ;LIST CHARACTER OUT
E212 C302E3                       JMP      PUNCH             ;PUNCH CHARACTER OUT
E215 C305E3                       JMP      READER            ;READER CHARACTER OUT
E218 C308E3                       JMP      HOME              ;MOVE HEAD TO HOME POSITION
E21B C30EE3                       JMP      SELDSK            ;SELECT DISK
E21E C32AE3                       JMP      SETTRK            ;SET TRACK NUMBER
E221 C332E3                       JMP      SETSEC            ;SET SECTOR NUMBER
E224 C339E3                       JMP      SETDMA            ;SET DMA ADDRESS
E227 C34BE3                       JMP      READ              ;READ DISK
E22A C366E3                       JMP      WRITE             ;WRITE DISK
E22D C3FFE2                       JMP      LISTST            ;RETURN LIST STATUS
E230 C341E3                       JMP      SECTRAN           ;SECTOR TRANSLATE
                         ;
                         ;DUMMY LIST OF JUMP VECTORS, USED TO TRANSFER CALLS TO USERS FLOPPY
                         ;DISK SYSTEM.  THIS TABLE IS OVERLAYED WITH THE USERS JUMP TABLE
                         ;
                         ;
                         ;
                         ;        >>>>>  REMOVE THIS SECTION OF DUMMY JUMP VECTORS.  <<<<<
                         ;
                         ;
E233 0000C9              XBOOT:            NOP!NOP!RET       ;COLD START
E236 0000C9              XWBOOT:           NOP!NOP!RET       ;WARM START
E239 0000C9              XCONST:           NOP!NOP!RET       ;CONSOLE STATUS
E23C 0000C9              XCONIN:           NOP!NOP!RET       ;CONSOLE CHARACTER IN
E23F 0000C9              XCNOUT:           NOP!NOP!RET       ;CONSOLE CHARACTER OUT
E242 0000C9              XLIST:            NOP!NOP!RET       ;LIST CHARACTER OUT
E245 0000C9              XPUNCH:           NOP!NOP!RET       ;PUNCH CHARACTER OUT
E248 0000C9              XREADR:           NOP!NOP!RET       ;READER CHARACTER OUT
E24B 0000C9              XHOME:            NOP!NOP!RET       ;MOVE HEAD TO HOME POSITION
E24E 0000C9              XSLDSK:           NOP!NOP!RET       ;SELECT DISK
E251 0000C9              XSETRK:           NOP!NOP!RET       ;SET TRACK NUMBER
E254 0000C9              XSTSEC:           NOP!NOP!RET       ;SET SECTOR NUMBER
E257 0000C9              XSTDMA:           NOP!NOP!RET       ;SET DMA ADDRESS
E25A 0000C9              XREAD:            NOP!NOP!RET       ;READ DISK
E25D 0000C9              XWRITE:           NOP!NOP!RET       ;WRITE DISK
E260 0000C9              XLSTST:           NOP!NOP!RET       ;RETURN LIST STATUS
E263 0000C9              XSCTRN:           NOP!NOP!RET       ;SECTOR TRANSLATE
                         ;
                         ;
                                  MACLIB   DISKDEF
                                  DISKS    1
E266+=                   DPBASE   EQU      $         ;BASE OF DISK PARAMETER BLOCKS
E266+00000000            DPE0:    DW       XLT0,0000H        ;TRANSLATE TABLE
E26A+00000000                     DW       0000H,0000H       ;SCRATCH AREA
E26E+B5E676E2                     DW       DIRBUF,DPB0       ;DIR BUFF,PARM BLOCK
E272+99E935E7                     DW       CSV0,ALV0         ;CHECK, ALLOC VECTORS
                                  DISKDEF  0,0,63,,2048,4896,612,0,1
E276+=                   DPB0     EQU      $                 ;DISK PARM BLOCK
E276+4000                         DW       64                ;SEC PER TRACK
E278+04                           DB       4                 ;BLOCK SHIFT
E279+0F                           DB       15                ;BLOCK MASK
E27A+00                           DB       0                 ;EXTNT MASK
E27B+1F13                         DW       4895              ;DISK SIZE-1
E27D+6302                         DW       611               ;DIRECTORY MAX
E27F+FF                           DB       255               ;ALLOC0
E280+C0                           DB       192               ;ALLOC1
```

Listing 1 continued on page 388

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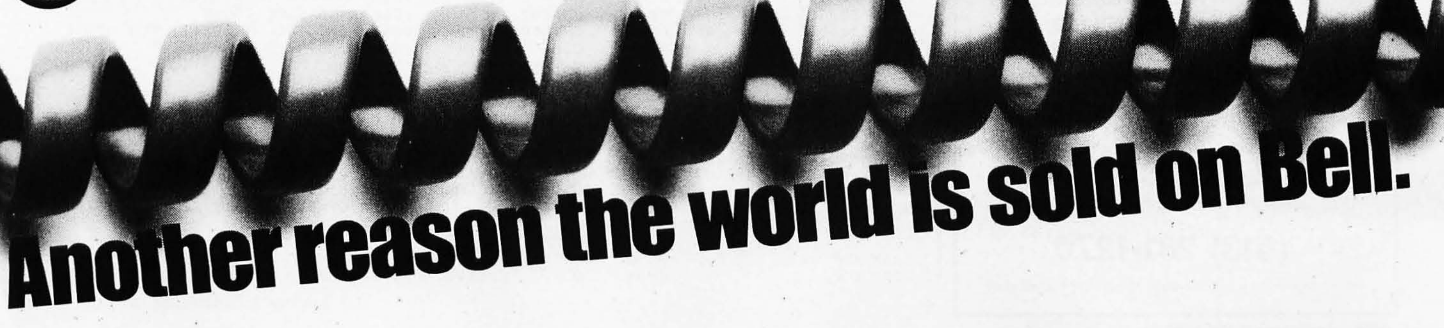
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Listing 1 continued:

```
E281+0000                    DW      0                 ;CHECK SIZE
E283+0100                    DW      1                 ;OFFSET
0000+=             XLT0      EQU     0                 ;NO XLATE TABLE
                   ;
                   ;         >>>>>  ADD YOUR HAND CODED OR MACRO GENERATED  <<<<<
                   ;         >>>>>  DISK PARAMETER TABLES HERE.             <<<<<
                   ;
                   ;
                   ;
                   ;         UTILITY MACRO TO COMPUTE SECTOR MASK
                             SMASK   MACRO   HBLK
                   ;;        COMPUTE LOG2(HBLK), RETURN @X AS RESULT
                   ;;        (2 ** @X = HBLK ON RETURN)
                   @Y        SET     HBLK
                   @X        SET     0
                   ;;        COUNT RIGHT SHIFTS OF @Y UNTIL = 1
                             REPT    8
                             IF      @Y = 1
                             EXITM
                             ENDIF
                   ;;        @Y IS NOT 1, SHIFT RIGHT ONE POSITION
                   @Y        SET     @Y SHR 1
                   @X        SET     @X + 1
                             ENDM
                             ENDM
                   ;
                   ;*****************************************************
                   ;*                                                   *
                   ;*           CP/M TO HOST DISK CONSTANTS             *
                   ;*                                                   *
                   ;*****************************************************
                   ;
0800 =             BLKSIZ    EQU     2048              ;CP/M ALLOCATION SIZE
0100 =             HSTSIZ    EQU     256               ;HOST DISK SECTOR SIZE
0020 =             HSTSPT    EQU     32                ;HOST DISK SECTORS/TRK
0002 =             HSTBLK    EQU     HSTSIZ/128        ;CP/M SECTS/HOST BUFF
0040 =             CPMSPT    EQU     HSTBLK * HSTSPT   ;CP/M SECTORS/TRACK
0001 =             SECMSK    EQU     HSTBLK-1          ;SECTOR MASK
                             SMASK   HSTBLK            ;COMPUTE SECTOR MASK
0001 =             SECSHF    EQU     @X                ;LOG2(HSTBLK)
                   ;
                   ;*****************************************************
                   ;*                                                   *
                   ;*          BDOS CONSTANTS ON ENTRY TO WRITE         *
                   ;*                                                   *
                   ;*****************************************************
0000 =             WRALL     EQU     0                 ;WRITE TO ALLOCATED
0001 =             WRDIR     EQU     1                 ;WRITE TO DIRECTORY
0002 =             WRUAL     EQU     2                 ;WRITE TO UNALLOCATED
                   ;
                   ;
                   ;*****************************************************
                   ;*                                                   *
                   ;*          A.S.C. HOST INTERFACE TO XEBEC HARD      *
                   ;*          DISK CONTROLLER CONSTANTS.               *
                   ;*                                                   *
                   ;*****************************************************
                   ;
00A0 =             CNTRL     EQU     0A0H              ;COMMAND CONTROL PORT
00A1 =             DATA      EQU     0A1H              ;DATA I/O PORT.
00A2 =             ASCPROM   EQU     0A2H              ;BIT 5=1 PROM ON, BIT 5=0 PROM OFF
00A3 =             RSTPT     EQU     0A3H              ;CONTROLLER RESET PORT
000A =             WRTCMD    EQU     0AH               ;WRITE COMMAND
0008 =             READCMD   EQU     08H               ;READ COMMAND
0003 =             ERRCMD    EQU     03H               ;RETREIVE ERROR COMMAND
0001 =             SELECT    EQU     01H               ;SELECT DISK COMMAND
0002 =             CMDAT     EQU     02H               ;COMMAND/DATA BIT
0004 =             BUSY      EQU     04H               ;CONTROLLER BUSY BIT
0010 =             REQ       EQU     010H              ;REQUEST COMMAND BIT
                   ;
                   ;
                   ;         INDIVIDUAL SUBROUTINES TO PERFORM EACH FUNCTION
                   BOOT:     ;SIMPLEST CASE IS TO JUST PERFORM PARAMETER INITIALIZATION
E285 AF                      XRA     A                 ;ZERO IN THE ACCUM
E286 320400                  STA     CDISK             ;SELECT DISK ZERO
E289 32A4E5                  STA     HSTACT            ;HOST BUFFER INACTIVE.
E28C 32A6E5                  STA     UNACNT            ;CLEAR UNALLOC COUNT.
E28F D3A2                    OUT     ASCPROM           ;TURN OFF BOOT PROM
                   ;
                   ;         >>>>>  ADD ANY SPECIFIC SYSTEM HARDWARE INITALIZATION  <<<<<
                   ;         >>>>>  CODE HERE (EG. USART INITIALIZATION CODE)       <<<<<
                   ;
E291 C3D2E2                  JMP     GOCPM             ;INITIALIZE AND GO TO CP/M
                   ;
                   ;
                   ;
                   WBOOT:    ;SIMPLEST CASE IS TO READ THE DISK UNTIL ALL SECTORS LOADED
E294 AF                      XRA     A                 ;
E295 32A4E5                  STA     HSTACT            ;HOST BUFFER INACTIVE.
E298 32A6E5                  STA     UNACNT            ;CLEAR UNALLOC COUNT.
E29B 318000                  LXI     SP,80H            ;USE SPACE BELOW BUFFER FOR STACK
E29E 0E00                    MVI     C,0               ;SELECT DISK 0
E2A0 CD0EE3                  CALL    SELDSK
E2A3 CD08E3                  CALL    HOME              ;GO TO TRACK 00
                   ;
E2A6 062C                    MVI     B,NSECTS          ;B COUNTS # OF SECTORS TO LOAD
E2A8 0E00                    MVI     C,0               ;C HAS THE CURRENT TRACK NUMBER
E2AA 1601                    MVI     D,1               ;D HAS THE NEXT SECTOR TO READ
                   ; NOTE THAT WE BEGIN BY READING TRACK 0, SECTOR 1 SINCE SECTOR 0
                   ; CONTAINS THE COLD START LOADER, WHICH IS SKIPPED IN A WARM START
E2AC 2100CC                  LXI     H,CCP             ;BASE OF CP/M (INITIAL LOAD POINT)
                   LOAD1:
                             ;LOAD ONE MORE SECTOR
E2AF C5                      PUSH    B        ;SAVE SECTOR COUNT, CURRENT TRACK
E2B0 D5                      PUSH    D        ;SAVE NEXT SECTOR TO READ
```

Listing 1 continued on page 390

Listing 1 continued:

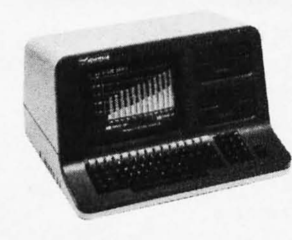
```
E2C0 C294E2          JNZ     WBOOT   ;RETRY THE ENTIRE BOOT IF AN ERROR OCCURS
                ;
                ;        NO ERROR, MOVE TO NEXT SECTOR
E2C3 E1              POP     H       ;RECALL DMA ADDRESS
E2C4 118000          LXI     D,128   ;DMA=DMA+128
E2C7 19              DAD     D       ;NEW DMA ADDRESS IS IN H,L
E2C8 D1              POP     D       ;RECALL SECTOR ADDRESS
E2C9 C1              POP     B       ;NUMBER OF SECTORS REMAINING, CURRENT TRK
E2CA 05              DCR     B       ;SECTORS=SECTORS-1
E2CB CAD2E2          JZ      GOCPM   ;TRANSFER TO CP/M IF ALL HAVE BEEN LOADED
                ;
E2CE 14              INR     D
E2CF C3AFE2          JMP     LOAD1   ;LOAD MORE BDOS CODE
                ;
                GOCPM:
                ;        END OF LOAD OPERATION, SET PARAMETERS AND GO TO CP/M
E2D2 3EC3            MVI     A,0C3H  ;C3 IS A JMP INSTRUCTION
E2D4 320000          STA     0       ;FOR JMP TO WBOOT
E2D7 2103E2          LXI     H,WBOOTE        ;WBOOT ENTRY POINT
E2DA 220100          SHLD    1       ;SET ADDRESS FIELD FOR JMP AT 0
                ;
E2DD 320500          STA     5       ;FOR JMP TO BDOS
E2E0 2106D4          LXI     H,BDOS  ;BDOS ENTRY POINT
E2E3 220600          SHLD    6       ;ADDRESS FIELD OF JUMP AT 5 TO BDOS
                ;
E2E6 018000          LXI     B,80H   ;DEFAULT DMA ADDRESS IS 80H
E2E9 CD39E3          CALL    SETDMA
                ;
E2EC 3A0400          LDA     CDISK   ;GET CURRENT DISK NUMBER
E2EF 4F              MOV     C,A     ;SEND TO THE CCP
E2F0 C300CC          JMP     CCP     ;GO TO CP/M FOR FURTHER PROCESSING
                ;
                ;
                ;        >>>>>  THE FOLLOWING SIMPLE I/O ROUTINES MUST BE  <<<<<
                ;        >>>>>  FILLED WITH THE USERS OWN SYSTEM ROUTINES  <<<<<
                ;
                CONST:  ;CONSOLE STATUS, RETURN 0FFH IF CHARACTER READY, 00H IF NOT
E2F3 C339E2          JMP     XCONST  ;SENT TO USER JMP VECTOR
                ;
                ;
                CONIN:  ;CONSOLE CHARACTER INTO REGISTER A
E2F6 C33CE2          JMP     XCONIN  ;SEND TO USER JMP VECTOR
                ;
                ;
                CONOUT: ;CONSOLE CHARACTER OUTPUT FROM REGISTER C
E2F9 C33FE2          JMP     XCNOUT  ;SEND TO USER JMP VECTOR
                ;
                ;
                LIST:   ;LIST CHARACTER FROM REGISTER C
E2FC C342E2          JMP     XLIST   ;SEND TO USER JMP VECTOR
                ;
                LISTST: ;RETURN LIST STATUS (0 IF NOT READY, 1 IF READY)
E2FF C360E2          JMP     XLSTST  ;SEND TO USER JMP VECTOR
                ;
                PUNCH:  ;PUNCH CHARACTER FROM REGISTER C
E302 C345E2          JMP     XPUNCH  ;SEND TO USER JMP VECTOR
                ;
                READER: ;READ CHARACTER INTO REGISTER A FROM READER DEVICE
E305 C348E2          JMP     XREADR  ;SEND TO USER JMP VECTOR
                ;
                ;
                ;        I/O DRIVERS FOR THE DISK FOLLOW
                ;        FOR NOW, WE WILL SIMPLY STORE THE PARAMETERS AWAY FOR USE
                ;        IN THE READ AND WRITE SUBROUTINES
                ;
                HOME:   ;MOVE TO THE TRACK 00 POSITION OF CURRENT DRIVE
                ;        TRANSLATE THIS CALL INTO A SETTRK CALL WITH PARAMETER 00
E308 010000          LXI     B,0     ;SELECT TRACK 0
E30B C32AE3          JMP     SETTRK  ;WE WILL MOVE TO 00 ON FIRST READ/WRITE
                ;
                ;
                SELDSK:
                        ;SELECT DISK
E30E 79              MOV     A,C             ;SELECTED DISK NUMBER
E30F 329BE5          STA     SEKDSK          ;SEEK DISK NUMBER
E312 0D              DCR     C               ;LOAD ALTERNATE DRIVE
E313 B7              ORA     A               ;CHECK FOR HARD DISK
E314 C24EE2          JNZ     XSLDSK          ;GO SELECT ALTERNATE DRIVE
E317 0C              INR     C               ;RESTORE HARD DISK NUMBER
E318 210000          LXI     H,0000          ;LOAD ERROR CODE
E31B FE01            CPI     NUDISKS         ;CHECK AGAINST MAX # DISKS
E31D D0              RNC                     ;NO CARRY IF GREATER
E31E 6F              MOV     L,A             ;DISK NUMBER TO HL
E31F 2600            MVI     H,0
                     REPT    4               ;MULTIPLY BY 16
                     DAD     H
                     ENDM
E321+29              DAD     H
E322+29              DAD     H
E323+29              DAD     H
E324+29              DAD     H
E325 1166E2          LXI     D,DPBASE        ;BASE OF PARM BLOCK
E328 19              DAD     D               ;HL=.DPB(CURDSK)
E329 C9              RET
                ;
                SETTRK:
                        ;SET TRACK GIVEN BY REGISTERS BC
E32A 60              MOV     H,B
E32B 69              MOV     L,C
E32C 229CE5          SHLD    SEKTRK          ;TRACK TO SEEK
                ;
                ;        >>>>>  ENTER YOUR SYSTEM SET TRACK ROUTINE HERE  <<<<<
E2B1 E5              PUSH    H       ;SAVE DMA ADDRESS
E2B2 4A              MOV     C,D     ;GET SECTOR ADDRESS TO REGISTER C
E2B3 CD32E3          CALL    SETSEC  ;SET SECTOR ADDRESS FROM REGISTER C
```

Listing 1 continued on page 392

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Listing 1 continued:

```
E2B6 C1              POP    B        ;RECALL DMA ADDRESS TO B,C
E2B7 C5              PUSH   B        ;REPLACE ON STACK FOR LATER RECALL
E2B8 CD39E3          CALL   SETDMA   ;SET DMA ADDRESS FROM B,C
                ;
                ;    DRIVE SET TO 0, TRACK SET, SECTOR SET, DMA ADDRESS SET
E2BB CD4BE3          CALL   READ
E2BE FE00            CPI    00H      ;ANY ERRORS?
                ;
                ;MAYBE THIS CALL IS FOR ANOTHER DRIVE
                ;BETTER GO SET THE TRACK NUMBER
E32F C351E2          JMP    XSETRK
                ;
                SETSEC:
                     ;SET SECTOR GIVEN BY REGISTER C
E332 79              MOV    A,C
E333 329EE5          STA    SEKSEC           ;SECTOR TO SEEK
                ;
                ;    >>>>>  PLACE YOUR SYSTEM SET SECTOR ROUTINE HERE.  <<<<<
                ;
                ;MAYBE THIS CALL IS FOR ANOTHER DRIVE
                ;BETTER GO SET THE SECTOR NUMBER
E336 C354E2          JMP    XSTSEC
                ;
                SETDMA:
                     ;SET DMA ADDRESS GIVEN BY BC
E339 60              MOV    H,B
E33A 69              MOV    L,C
E33B 22B3E5          SHLD   DMAADR           ;LOAD DMA ADDRESS
                ;
                ;    >>>>>  PLACE YOUR SYSTEM SET DMA ROUTINE HERE.  <<<<<
                ;
                ;MAYBE THIS CALL IS FOR ANOTHER DRIVE
                ;BETTER GO SET THE DMA ADDRESS
E33E C357E2          JMP    XSTDMA
                ;
                SECTRAN:
                     ;TRANSLATE SECTOR NUMBER BC
E341 3A9BE5          LDA    SEKDSK           ;GET DISK NUMBER
E344 B7              ORA    A                ;CHECK FOR HARD DISK
                ;
                ;    >>>>> CHANGE THE FOLLOWING JNZ XSCTRN CODE TO  JUMP TO  <<<<<
                ;    >>>>> YOUR SYSTEM SECTOR TRANSLATION ROUTINE.           <<<<<
                ;
E345 C263E2          JNZ    XSCTRN           ;TRANSLATE OTHER SECTOR NUMBER
E348 60              MOV    H,B
E349 69              MOV    L,C
E34A C9              RET
                ;
                ;
                ;*****************************************************
                ;*                                                   *
                ;*   THE READ ENTRY POINT TAKES THE PLACE OF         *
                ;*   THE PREVIOUS BIOS DEFINTION FOR READ.           *
                ;*                                                   *
                ;*****************************************************
                READ:
                     ;READ THE SELECTED CP/M SECTOR
E34B 3A9BE5          LDA    SEKDSK           ;GET DISK NUMBER
E34E B7              ORA    A                ;CHECK FOR HARD DISK A:
                ;
                ;    >>>>>  CHANGE THE FOLLOWING JNZ XREAD TO JUMP TO YOUR  <<<<<
                ;    >>>>>  SYSTEM READ ROUTINE.                            <<<<<
                ;
E34F C25AE2          JNZ    XREAD            ;READ ALTERNATE DISK
E352 AF              XRA    A
E353 32A6E5          STA    UNACNT
E356 3E01            MVI    A,1
E358 32B1E5          STA    READOP           ;READ OPERATION
E35B 32B0E5          STA    RSFLAG           ;MUST READ DATA
E35E 3E02            MVI    A,WRUAL
E360 32B2E5          STA    WRTYPE           ;TREAT AS UNALLOC
E363 C3D8E3          JMP    RWOPER           ;TO PERFORM THE READ
                ;
                ;*****************************************************
                ;*                                                   *
                ;*   THE WRITE ENTRY POINT TAKES THE PLACE OF        *
                ;*   THE PREVIOUS BIOS DEFINTION FOR WRITE.          *
                ;*                                                   *
                ;*****************************************************
                WRITE:
                     ;WRITE THE SELECTED CP/M SECTOR
E366 3A9BE5          LDA    SEKDSK           ;GET DISK NUMBER
E369 B7              ORA    A                ;CHECK FOR HARD DISK A:
                ;
                ;    >>>>>  CHANGE THE FOLLOWING JNZ XWRITE CODE TO JUMP TO  <<<<<
                ;    >>>>>  YOUR SYSTEM WRITE ROUTINE.                       <<<<<
                ;
E36A C25DE2          JNZ    XWRITE           ;WRITE ALTERNATE DISK
E36D AF              XRA    A                ;0 TO ACCUMULATOR
E36E 32B1E5          STA    READOP           ;NOT A READ OPERATION
E371 79              MOV    A,C              ;WRITE TYPE IN C
E372 32B2E5          STA    WRTYPE
E375 FE02            CPI    WRUAL            ;WRITE UNALLOCATED?
E377 C291E3          JNZ    CHKUNA           ;CHECK FOR UNALLOC
                ;
                ;    WRITE TO UNALLOCATED, SET PARAMETERS
E37A 3E10            MVI    A,BLKSIZ/128     ;NEXT UNALLOC RECS
E37C 32A6E5          STA    UNACNT
E37F 3A9BE5          LDA    SEKDSK           ;DISK TO SEEK
E382 32A7E5          STA    UNADSK           ;UNADSK = SEKDSK
E385 2A9CE5          LHLD   SEKTRK
E388 22A8E5          SHLD   UNATRK           ;UNATRK = SECTRK
E38B 3A9EE5          LDA    SEKSEC
E38E 32AAE5          STA    UNASEC           ;UNASEC = SEKSEC
                ;
                CHKUNA:
```

Listing 1 continued on page 394



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Listing 1 continued:

```
                    ;CHECK FOR WRITE TO UNALLOCATED SECTOR
E391 3AA6E5         LDA     UNACNT          ;ANY UNALLOC REMAIN?
E394 B7             ORA     A
E395 CAD0E3         JZ      ALLOC           ;SKIP IF NOT
              ;
              ;     MORE UNALLOCATED RECORDS REMAIN
E398 3D             DCR     A               ;UNACNT = UNACNT-1
E399 32A6E5         STA     UNACNT
E39C 3A9BE5         LDA     SEKDSK          ;SAME DISK?
E39F 21A7E5         LXI     H,UNADSK
E3A2 BE             CMP     M               ;SEKDSK = UNADSK?
E3A3 C2D0E3         JNZ     ALLOC           ;SKIP IF NOT
              ;
              ;     DISKS ARE THE SAME
E3A6 21A8E5         LXI     H,UNATRK
E3A9 CD73E4         CALL    SEKTRKCMP       ;SEKTRK = UNATRK?
E3AC C2D0E3         JNZ     ALLOC           ;SKIP IF NOT
              ;
              ;     TRACKS ARE THE SAME
E3AF 3A9EE5         LDA     SEKSEC          ;SAME SECTOR?
E3B2 21AAE5         LXI     H,UNASEC
E3B5 BE             CMP     M               ;SEKSEC = UNASEC?
E3B6 C2D0E3         JNZ     ALLOC           ;SKIP IF NOT
              ;
              ;     MATCH, MOVE TO NEXT SECTOR FOR FUTURE REF
E3B9 34             INR     M               ;UNASEC = UNASEC+1
E3BA 7E             MOV     A,M             ;END OF TRACK?
E3BB FE40           CPI     CPMSPT          ;COUNT CP/M SECTORS
E3BD DAC9E3         JC      NOOVF           ;SKIP IF NO OVERFLOW
              ;
              ;     OVERFLOW TO NEXT TRACK
E3C0 3600           MVI     M,0             ;UNASEC = 0
E3C2 2AA8E5         LHLD    UNATRK
E3C5 23             INX     H
E3C6 22A8E5         SHLD    UNATRK          ;UNATRK = UNATRK+1
              ;
              NOOVF:
                    ;MATCH FOUND, MARK AS UNNECESSARY READ
E3C9 AF             XRA     A               ;0 TO ACCUMULATOR
E3CA 32B0E5         STA     RSFLAG          ;RSFLAG = 0
E3CD C3D8E3         JMP     RWOPER          ;TO PERFORM THE WRITE
              ;
              ALLOC:
                    ;NOT AN UNALLOCATED RECORD, REQUIRES PRE-READ
E3D0 AF             XRA     A               ;0 TO ACCUM
E3D1 32A6E5         STA     UNACNT          ;UNACNT = 0
E3D4 3C             INR     A               ;1 TO ACCUM
E3D5 32B0E5         STA     RSFLAG          ;RSFLAG = 1
              ;
              ;*****************************************************
              ;*                                                   *
              ;*    COMMON CODE FOR READ AND WRITE FOLLOWS         *
              ;*                                                   *
              ;*****************************************************
              RWOPER:
                    ;ENTER HERE TO PERFORM THE READ/WRITE
E3D8 AF             XRA     A               ;ZERO TO ACCUM
E3D9 32AFE5         STA     ERFLAG          ;NO ERRORS (YET)
E3DC 3A9EE5         LDA     SEKSEC          ;COMPUTE HOST SECTOR
                    REPT    SECSHF
                    ORA     A               ;CARRY = 0
                    RAR                     ;SHIFT RIGHT
                    ENDM
E3DF+B7             ORA     A               ;CARRY = 0
E3E0+1F             RAR                     ;SHIFT RIGHT
E3E1 32A3E5         STA     SEKHST          ;HOST SECTOR TO SEEK
              ;
              ;     ACTIVE HOST SECTOR?
E3E4 21A4E5         LXI     H,HSTACT        ;HOST ACTIVE FLAG
E3E7 7E             MOV     A,M
E3E8 3601           MVI     M,1             ;ALWAYS BECOMES 1
E3EA B7             ORA     A               ;WAS IT ALREADY?
E3EB CA12E4         JZ      FILHST          ;FILL HOST IF NOT
              ;
              ;     HOST BUFFER ACTIVE, SAME AS SEEK BUFFER?
E3EE 3A9BE5         LDA     SEKDSK
E3F1 219FE5         LXI     H,HSTDSK        ;SAME DISK?
E3F4 BE             CMP     M               ;SEKDSK = HSTDSK?
E3F5 C20BE4         JNZ     NOMATCH
              ;
              ;     SAME DISK, SAME TRACK?
E3F8 21A0E5         LXI     H,HSTTRK
E3FB CD73E4         CALL    SEKTRKCMP       ;SEKTRK = HSTTRK?
E3FE C20BE4         JNZ     NOMATCH
              ;
              ;     SAME DISK, SAME TRACK, SAME BUFFER?
E401 3AA3E5         LDA     SEKHST
E404 21A2E5         LXI     H,HSTSEC        ;SEKHST = HSTSEC?
E407 BE             CMP     M
E408 CA2FE4         JZ      MATCH           ;SKIP IF MATCH
              ;
              NOMATCH:
                    ;PROPER DISK, BUT NOT CORRECT SECTOR
E40B 3AA5E5         LDA     HSTWRT          ;HOST WRITTEN?
E40E B7             ORA     A
E40F C47FE4         CNZ     WRITEHST        ;CLEAR HOST BUFF
              ;
              FILHST:
                    ;MAY HAVE TO FILL THE HOST BUFFER
E412 3A9BE5         LDA     SEKDSK
E415 329FE5         STA     HSTDSK
E418 2A9CE5         LHLD    SEKTRK
E41B 22A0E5         SHLD    HSTTRK
E41E 3AA3E5         LDA     SEKHST
E421 32A2E5         STA     HSTSEC
```

Listing 1 continued on page 396

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TV-910	Televideo 910	699	573
TV-912	Televideo 912C	925	685
TV-920	Televideo 920C	995	737
TV-925	Televideo 925	995	745
TV-950	Televideo 950	1195	921
TV-970	Televideo 970		Call
TV-9010	Second Page Option 912/920	80	50
TV-9051	One Additional Page for 925/950	95	62
TV-MM	Three Additional Pages for 950	120	95
TS-24-001	For Any Televideo Terminal	60	53
TS-806H/20	TeleSolutions WordStar		
TS-TW	+ CalcStar	790	Call
	20 MB Expansion for TS-806	3600	2948
	Telewriter - NEC 3500	2195	1629

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NS-94404	Adv-2Q-64K Computer	3599	Call
NS-97404	Adv-1Q-64K-HD-5 Computer	4999	Call
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NS-97401	Hrz-1Q-64K-HD-5MB	4999	Call

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Z-19-CN	Z-19 Terminal	895	672
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Z-25-AA	Z-25 Dot Matrix Printer	1499	1198
Z-89-81	Z-89 Computer System	1995	Call
Z-90-82	Z-90 Computer System	2799	2176
Z-89-X	Z-89 w/o Integral Drive	2495	1749
Z-90-80	Z-90 w/o Integral Drive	2895	1950
Z-37	Z-37 Dual 5" Disk Drives	1995	1593
Z-87-89	Z87 Dual 5" Disk Drives	999	898
Z-87-90	Same Disk add 400K to Z-90	999	898
ZS-67	Z-67 Winchester - Floppy Drive	5995	4747
Z-47-DA	Z47 Dual 8" Disk Drives	3695	Call

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NE-3510-1	NEC 3510 Spinwriter R/O Serial 35 CPS	1895	Call
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NE-3530-1	NEC 3530 Spinwriter	1995	Call
NE-3550-1	NEC 3550 Spinwriter R/O Parallel IBM Compatible	2350	Call
NE-35-TRAC	Bi-directional Tractor	265	Call
NE-7710-1	NEC 7710 Spinwriter R/O Serial 55 CPS	2795	Call
NE-7715-1	NEC 7715 Spinwriter R/O Serial Diablo Comp.	2825	Call
NE-7720-1	NEC 7720 Spinwriter KSR Serial 55 CPS	3610	Call
NE-7725-1	NEC 7725 Spinwriter KSR Serial Diablo Comp.	3710	Call
NE-7730-1	NEC 7730 Spinwriter	2795	Call
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Gemini-15	15" Carriage - Parallel	649	Call
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DP-8240	40 Column Dot Matrix - Parallel or Serial	250	Call

OKIDATA

ORDER NO.	DESCRIPTION	LIST	AEI PRICE
OK-82A	Okidata Microline 82A with Tractor Feed	719	486
OK-83A	Okidata Microline 83A	1195	713
OK-84A-P	Okidata Microline 84A - Parallel	1395	Call
OK-84A-S	Okidata Microline 84A - Serial	1495	Call
OK-G-82	Okigraph I for 82A	99	45
OK-G-83	Okigraph I for 83A	99	45
OK-2K	2K Buffer/Serial BD all Models	140	119

MANNESMANN TALLY

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MT1802	Parallel - 200 CPS or 50 CPS	1995	Call
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- DEC VT-180 CP/M 5¼"
- Eagle CP/M 5¼"
- Heath Z-90 CP/M 5¼"
- Heath Zenith CP/M 5¼"
- Hewlett Packard 125 CP/M 5¼"
- Hewlett Packard 87 CP/M 5¼"
- IBM P.C. CP/M 86
- IBM P.C. DOS
- NEC CP/M 5¼"
- Northstar Advantage CP/M 5¼"
- Northstar Horizon CP/M 5¼"
- Ohio Scientific C-3 CP/M 5¼"
- Osborne CP/M 5¼"
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- TRS-80 Diskette Models I & III
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Listing 1 continued:

```
E424 3AB0E5          LDA     RSFLAG          ;NEED TO READ?
E427 B7              ORA     A
E428 C487E4          CNZ     READHST         ;YES, IF 1
E42B AF              XRA     A               ;0 TO ACCUM
E42C 32A5E5          STA     HSTWRT          ;NO PENDING WRITE
                ;
                MATCH:
                        ;COPY DATA TO OR FROM BUFFER
E42F 3A9EE5          LDA     SEKSEC          ;MASK BUFFER NUMBER
E432 E601            ANI     SECMSK          ;LEAST SIGNIF BITS
E434 6F              MOV     L,A             ;READY TO SHIFT
E435 2600            MVI     H,0             ;DOUBLE COUNT
                     REPT    7               ;SHIFT LEFT 7
                     DAD     H
                     ENDM
E437+29              DAD     H
E438+29              DAD     H
E439+29              DAD     H
E43A+29              DAD     H
E43B+29              DAD     H
E43C+29              DAD     H
E43D+29              DAD     H
                ;    HL HAS RELATIVE HOST BUFFER ADDRESS
E43E 11B5E5          LXI     D,HSTBUF
E441 19              DAD     D               ;HL = HOST ADDRESS
E442 EB              XCHG                    ;NOW IN DE
E443 2AB3E5          LHLD    DMAADR          ;GET/PUT CP/M DATA
E446 0E80            MVI     C,128           ;LENGTH OF MOVE
E448 3AB1E5          LDA     READOP          ;WHICH WAY?
E44B B7              ORA     A
E44C C255E4          JNZ     RWMOVE          ;SKIP IF READ
                ;
                ;    WRITE OPERATION, MARK AND SWITCH DIRECTION
E44F 3E01            MVI     A,1
E451 32A5E5          STA     HSTWRT          ;HSTWRT = 1
E454 EB              XCHG                    ;SOURCE/DEST SWAP
                ;
                RWMOVE:
                        ;C INITIALLY 128, DE IS SOURCE, HL IS DEST
E455 1A              LDAX    D               ;SOURCE CHARACTER
E456 13              INX     D
E457 77              MOV     M,A             ;TO DEST
E458 23              INX     H
E459 0D              DCR     C               ;LOOP 128 TIMES
E45A C255E4          JNZ     RWMOVE
                ;
                ;    DATA HAS BEEN MOVED TO/FROM HOST BUFFER
E45D 3AB2E5          LDA     WRTYPE          ;WRITE TYPE
E460 FE01            CPI     WRDIR           ;TO DIRECTORY?
E462 3AAFE5          LDA     ERFLAG          ;IN CASE OF ERRORS
E465 C0              RNZ                     ;NO FURTHER PROCESSING
                ;
                ;    CLEAR HOST BUFFER FOR DIRECTORY WRITE
E466 B7              ORA     A               ;ERRORS?
E467 C0              RNZ                     ;SKIP IF SO
E468 AF              XRA     A               ;0 TO ACCUM
E469 32A5E5          STA     HSTWRT          ;BUFFER WRITTEN
E46C CD7FE4          CALL    WRITEHST
E46F 3AAFE5          LDA     ERFLAG
E472 C9              RET
                ;
                ;*****************************************************
                ;*                                                   *
                ;*      UTILITY SUBROUTINE FOR 16-BIT COMPARE        *
                ;*                                                   *
                ;*****************************************************
                SEKTRKCMP:
                        ;HL = .UNATRK OR .HSTTRK, COMPARE WITH SEKTRK
E473 EB              XCHG
E474 219CE5          LXI     H,SEKTRK
E477 1A              LDAX    D               ;LOW BYTE COMPARE
E478 BE              CMP     M               ;SAME?
E479 C0              RNZ                     ;RETURN IF NOT
                ;    LOW BYTES EQUAL, TEST HIGH 1S
E47A 13              INX     D
E47B 23              INX     H
E47C 1A              LDAX    D
E47D BE              CMP     M       ;SETS FLAGS
E47E C9              RET
                ;
                ;
                ;*****************************************************
                ;*                                                   *
                ;*      WRITEHST PERFORMS THE PHYSICAL WRITE TO      *
                ;*      THE HOST DISK, READHST READS THE PHYSICAL    *
                ;*      DISK.                                        *
                ;*                                                   *
                ;*****************************************************
                WRITEHST:
                        ;HSTDSK = HOST DISK #, HSTTRK = HOST TRACK #,
                        ;HSTSEC = HOST SECT #. WRITE "HSTSIZ" BYTES
                        ;FROM HSTBUF AND RETURN ERROR FLAG IN ERFLAG.
                        ;RETURN ERFLAG NON-ZERO IF ERROR
E47F 3E0A            MVI     A,WRTCMD                ;LOAD WRITE COMMAND
E481 CD8FE4          CALL    COMCODE         ;SEND COMMAND TO CONTROLLER
                WRTBUFF:
                        ;THIS LOOP SENDS BUFFER TO CONTROLLER
E484 C3ECE4          JMP     OUTLOOP         ;SEND OUT THE BUFFER

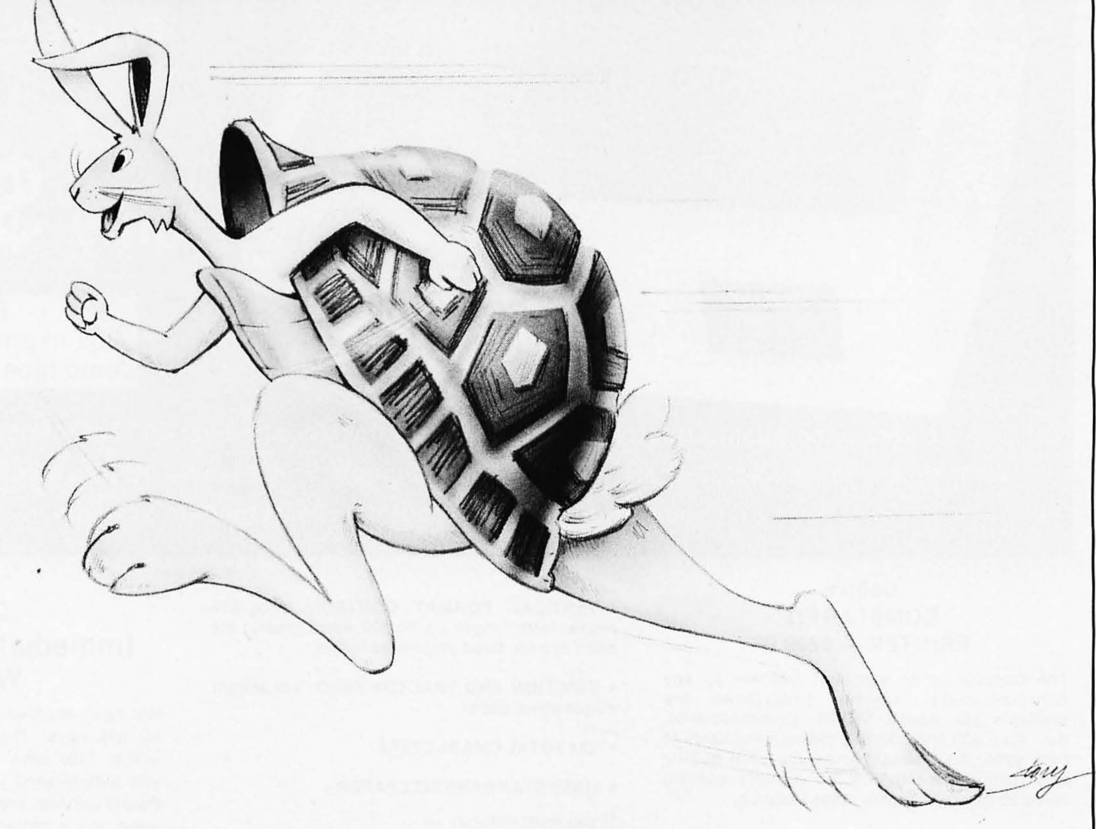
                ;
                READHST:
                        ;HSTDSK = HOST DISK #, HSTTRK = HOST TRACK #,
                        ;HSTSEC = HOST SECT #. READ "HSTSIZ" BYTES
                        ;INTO HSTBUF AND RETURN ERROR FLAG IN ERFLAG.
```

Listing 1 continued on page 398

Listing 1 continued:

```
E487 3E08                  MVI     A,READCMD          ;GET READ COMMAND
E489 CD8FE4                CALL    COMCODE            ;SEND COMMAND TO CONTROLLER
                   READBUF:
                           ;ROUTINE READS DATA INTO BUFFER
E48C C3FDE4                JMP     INLOOP             ;READ THE DATA
                   ;
                   COMCODE:
                           ;COMMON CODE FOR READ AND WRITE TO CONTROLLER
E48F 3295E5                STA     CMDBYT0            ;STORE COMMAND BYTE
E492 3A9FE5                LDA     HSTDSK             ;GET DISK NUMBER
                           REPT    5                  ;MOVE TO BIT POSITION
                           RAL                        ;
                           ENDM
E495+17                    RAL                        ;
E496+17                    RAL                        ;
E497+17                    RAL                        ;
E498+17                    RAL                        ;
E499+17                    RAL                        ;
E49A E6E0                  ANI     0E0H               ;MASK OFF HI ADDRESS DATA
E49C 3296E5                STA     CMDBYT1            ;SAVE IN COMMAND BLOCK
E49F 2AA0E5                LHLD    HSTTRK             ;GET TRACK NUMBER
                           REPT    5                  ; * 32 SECTOR/TRACK =# SECTORS
                           DAD     H                  ;
                           ENDM
E4A2+29                    DAD     H                  ;
E4A3+29                    DAD     H                  ;
E4A4+29                    DAD     H                  ;
E4A5+29                    DAD     H                  ;
E4A6+29                    DAD     H                  ;
E4A7 3AA2E5                LDA     HSTSEC             ;GET SECTOR #
E4AA 5F                    MOV     E,A                ;SET UP FOR ADD
E4AB AF                    XRA     A                  ;
E4AC 57                    MOV     D,A                ;
E4AD 19                    DAD     D                  ;ADD IN SECTOR NUMBER
E4AE 7D                    MOV     A,L                ;
E4AF 3298E5                STA     CMDBYT3            ;SAVE IN COMMAND BLOCK
E4B2 7C                    MOV     A,H                ;MSB OF ADDRESS
E4B3 3297E5                STA     CMDBYT2            ;SAVE IN COMMAND BLOCK
E4B6 3E01                  MVI     A,01               ;
E4B8 3299E5                STA     CMDBYT4            ;LOAD SECTOR COUNT
E4BB AF                    XRA     A                  ;DESELECT HALF STEP OPTION
E4BC 329AE5                STA     CMDBYT5            ;SELECT HALF STEP OPTION
E4BF 2195E5                LXI     H,CMDBYT0          ;START OF COMMAND BLOCK
E4C2 CDCCE4                CALL    SENDCMD            ;SEND COMMAND BLOCK TO CONTROLLER
E4C5 CDDFE4                CALL    CLRCMD             ;CLEAR THE COMMAND BUFFER
E4C8 21B5E5                LXI     H,HSTBUF           ;POINT TO TRANSFER BUFFER
E4CB C9                    RET
                   ;
                   SENDCMD:
                           ;SEND THE COMMAND BLOCK POINTED TO BY HL
E4CC CD11E5                CALL    SELCT              ;SELECT THE CONTROLLER
E4CF CD26E5                CALL    WAIT               ;WAIT FOR REQUEST
E4D2 0606                  MVI     B,6                ;COMMAND BYTE COUNT
                   SENDCD:
E4D4 7E                    MOV     A,M                ;GET COMMAND BYTE
E4D5 D3A1                  OUT     DATA               ;SEND IT TO CONTROLLER
E4D7 23                    INX     H                  ;NEXT BYTE
E4D8 05                    DCR     B                  ;KEEP TRACK
E4D9 C2D4E4                JNZ     SENDCD             ;
E4DC C326E5                JMP     WAIT               ;WAIT FOR REQUEST
                   ;
                   CLRCMD:
                           ;CLEAR COMMAND BLOCK
E4DF AF                    XRA     A                  ;LOAD ZERO
E4E0 0606                  MVI     B,6                ;BYTE COUNT
E4E2 2195E5                LXI     H,CMDBYT0          ;POINT TO FIRST BYTE
                   CLRCMD1:
E4E5 77                    MOV     M,A                ;CLEAR BYTE
E4E6 23                    INX     H                  ;
E4E7 05                    DCR     B                  ;SUB COUNT
E4E8 C2E5E4                JNZ     CLRCMD1            ;
E4EB C9                    RET                        ;
                   ;
                   OUTLOOP:
                           ;SEND OUT DATA UNTIL C/D BIT SIGNALS FINISH
E4EC DBA0                  IN      CNTRL              ;READ STATUS
E4EE E602                  ANI     CMDAT              ;CHECK C/D BIT
E4F0 CA2EE5                JZ      CKERR              ;DONE, CHECK FOR ERRORS
E4F3 7E                    MOV     A,M                ;GET OUTPUT BYTE
E4F4 D3A1                  OUT     DATA               ;TO CONTROLLER
E4F6 CD26E5                CALL    WAIT               ;REQUEST
E4F9 23                    INX     H                  ;NEXT BYTE
E4FA C3ECE4                JMP     OUTLOOP            ;KEEP LOOPING
                   ;
                   INLOOP:
                           ;READ DATA UNTIL C/D BIT SIGNALS FINISH
E4FD DBA0                  IN      CNTRL              ;READ STATUS
E4FF E602                  ANI     CMDAT              ;CHECK C/D BIT
E501 CA2EE5                JZ      CKERR              ;CHECK FOR ERRORS
E504 DBA1                  IN      DATA               ;READ BYTE
E506 77                    MOV     M,A                ;TO MEMORY
E507 CD26E5                CALL    WAIT               ;REQUEST
E50A 23                    INX     H                  ;NEXT LOCATION
E50B C3FDE4                JMP     INLOOP             ;KEEP LOOPING
                   ;
                   RESET:
                           ;RESET THE XEBEC DISK CONTROLLER
E50E D3A3                  OUT     RSTPT              ;SEND ANYTHING TO THE RESET PORT
E510 C9                    RET
                   ;
                   SELCT:
                           ;SELECT DISK 0 OF THE XEBEC CONTROLLER
```

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Using IBM's Marvelous Keyboard

It's simple to change IBM's keyboard to the Dvorak layout or use the keyboard with other computers and software.

David B. Glasco
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Optical Sciences Center
University of Arizona
Tucson, AZ 85721

Perhaps the most stunning feature of IBM's Personal Computer is its beautiful streamlined keyboard. Slim, solid, artistic, and versatile, it defines a new standard in keyboard design. Where did its unique layout come from, and is it superior to others? Can you obtain just the keyboard itself, and how can it be used with other computers? In this article, we'll study the IBM keyboard from the inside out to answer those questions. You'll see how to take full advantage of its power, and we'll show IBM Personal Computer owners a simple way to redefine the keyboard using the operating system. This will allow you to switch to the more efficient Dvorak keyboard layout, or to create your own layout that better suits special needs, such as entry of foreign-language and mathematical text.

Solidly built and with excellent tactile feel, the futuristic IBM Personal Computer keyboard can rest on a flat surface or be inclined and is detached from the main case of the Personal Computer so you can move it around to suit your mood. The choice of characters includes the English letters, Arabic digits, complete ASCII (American National Standard Code for Information Interchange) punctuation characters, 10 special-function keys (labeled F1 to F10), three shift keys (Ctrl, shift, and Alt), two shiftlock keys (Caps Lock and Num Lock), and 15 "cursor/ numeric keypad" keys. One badly needed key that isn't provided is a key labeled "Help." What might be accomplished by typing a Help key depends on software, but user-friendly systems should support such a key. Because the IBM Personal Computer lacks this key, the use of F1 as the Help key is becoming standard procedure in a lot of software.

Acknowledgments

We thank Mike Aronson, Curtis Feigel, Rick Shoemaker, and Mark Tiddens for helpful suggestions.

About the Authors

Murray Sargent III is a professor of optical sciences at the University of Arizona and an author of textbooks on laser physics and microcomputer interfacing. David B. Glasco, a microcomputer owner, is a senior at Canyon Del Oro High School.

The Layout

A fair amount of controversy exists concerning IBM's placement of some keys—specifically the shift, backslash, carriage-return, and delete keys. The latter two are often thought to be a bit farther from standard positions than desired, considering the high use they are likely to get. The location of the backslash (between the left shift key and the Z key) is heavily lamented in the U.S.A. because touch-typists are used to finding one large shift key that starts in the backslash position. A point partially justifying IBM's choice is that it's symmetric. On standard keyboards, e.g., the IBM Selectric typewriter, the forward slash occupies the position between the right shift key and the period, so why not have the backslash intervene between the Z and the left shift key? Furthermore, the right little finger has to move the same distance to reach its shift key as the left little finger does to reach its on the IBM Personal Computer keyboard.

The design follows the German DIN (Deutsche Industrie Norm) standards, for which extensive ergonomic studies were made to determine the most comfortable way for people to type. The backslash (or some other) character is often found between the left shift key and the Z on European keyboards, so Europeans feel this is quite natural. At any rate, after a few hours of experience, the backslash no longer presents a problem for a touch-typist (and it never did for anyone else; if this placement really bothers you, the programs provided here show how to change the keys to any order you desire). In addition, the standards specify labeling the backspace, tab, shift, and carriage-return keys with various arrows,

which is a bit confusing at first and presents typographical problems when one writes about these keys. Curiously enough, the IBM Personal Computer is only just now being marketed in Europe, despite the support of special foreign-language characters on the display screen.

Of Keyboards and Codes

IBM sells just the keyboard itself for $279. But, as with other components of the Personal Computer, the keyboard has been "cloned" by other manufacturers; it is available from Key Tronic, of Spokane, Washington, for $212, so you have more than one source for this kind of keyboard.

The Key Tronic version of the IBM Personal Computer keyboard has the same layout and comes with a variety of encoding options. One, called "IBM Personal Computer plug-compatible," works fine with the IBM Personal Computer. This particular model has small red indicators that light up when the Caps Lock or Num Lock functions have been activated. The keys have a very different feel from the IBM keys. As you press one of the Key Tronic keys, it offers almost no initial resistance, then when contact is made, it offers substantial resistance, thus giving a nice tactile feedback. If desired, you can continue to push down against this increased resistance until the bottom of travel is reached. With some practice, this keyboard requires less effort to type on than the IBM keyboard. In addition, it is less expensive and substantially quieter (you can type away while on the telephone without offending the other party). On the other hand, the keyboard doesn't feel or look as solidly built as the IBM version and lacks the IBM's convenient ledge that is useful for storing pencils and for supporting dust covers. Having used both fairly extensively, we prefer the IBM version somewhat but feel the Key Tronic is better than virtually any other keyboard we've used (and the people at Key Tronic would probably be willing to add a Help key).

One super feature of the IBM keyboard (and the Key Tronic clone) is that you can cause any key combination to create any code you want. To understand how this is done, let's examine the key-encoding scheme. The keyboard contains an Intel 8048 single-chip microcomputer that constantly scans all the keys. It sends out a serial pattern of bits (called the *make code*) when a key makes contact, and a similar pattern (the same pattern but with the high-order bit set, called the *break code*) when the contact is broken. If the contact is present for more than ½ second, the keyboard sends out the make code repetitively 10 times a second.

Like other components of the PC, the keyboard has been "cloned" by other manufacturers.

Each key is treated identically by the keyboard; any key could represent a shift key, a number, or a special function. And, because the duration of the depression of a key is reported precisely, you can use the keyboard for playing music and simulating simple joysticks, in addition to the usual typewriter applications. Meanwhile, the main computer doesn't have to waste time monitoring and "debouncing" the keyboard—that's all done by the dedicated 8048 microcomputer. The penalty one pays for this completely general flexibility is that the main computer does have to translate the make and break codes into standard ASCII, but that seems a minor price to pay.

The Joy of Software

Because of the great flexibility of the keyboard, you're really limited only by software—specifically, by the operating system. In this connection, perhaps the most significant improvement of PC-DOS over the 8-bit versions of CP/M is run-time extensibility. You can run a program that defines or redefines some capability in the system and leave it resident until the system is reloaded. Furthermore, when PC-DOS is reloaded, it automatically executes programs named in the AUTOEXEC.BAT file, so that you can bring up a substantially modified operating system with very little effort.

One example of run-time extension is the program in listing 1; it can redefine the keyboard to your specifications. The incoming make code or break code may be translated into any other make code or break code, so that any key can be made to play the role of any other. Then, if neither the Ctrl nor the Alt key is pressed, control is transferred to an appropriate point in the ROM BIOS (read-only memory basic input/output system) to finish the processing, translate the key's code into ASCII, or perform the function specified by the key.

If the Ctrl key is pressed, a couple of special values are checked to give meaning to Ctrl-uparrow and Ctrl-downarrow combinations. For these cases, the jump into the ROM BIOS occurs after all ROM translation and just before the final bit pattern is stored in the keyboard buffer. If the Alt key is pressed, a second table lookup translates the code into any desired 8-bit value and jumps to the ROM BIOS to store the new code in the keyboard buffer. (It is easy to convert our Z80 translator in listing 2 to run on the IBM and bypass the ROM BIOS routine altogether; however, it requires somewhat more memory, so we prefer this hybrid version.)

For the sake of demonstration, the program is initialized to set up the infamous backslash key as a shift key and the cursor pad's minus key as the backslash key. In practice, we've decided we really prefer to leave these keys alone so that they do what they are labeled to do. When running the program, you can switch to a Dvorak key layout by typing a Ctrl-enter combination. (This layout was proposed by Dr. A. Dvorak and his associates after carrying out extensive research on the relative use and sequences of letters. In particular, they placed the keys A, O, E, U, I, and D, H, T, N, S under the left-hand and right-hand standard positions, respectively. Because these characters

Text continued on page 408

Listing 1: *This program takes over the IBM PC keyboard interrupt (INT 9), translating input codes to values given in the internal tables. Initially, the layout is changed as detailed in the text. Typing a Ctrl-Enter combination switches the computer to the Dvorak keyboard layout; a Ctrl-Esc combination returns to the initial layout. Ctrl-backtab, Ctrl-uparrow, and Ctrl-downarrow combinations are translated to ^O, ^U, and ^] for use with the Pmate screen editor. Certain uppercase and lowercase letters are given alternate values. Control is then passed to the ROM routines for further processing.*

```
kb_data   equ       60h            ;Keyboard data port
kb_ctl    equ       61h            ;Keyboard control port

data      segment   at 40h
          org       17h
kb_flag   label     byte           ;RAM keyboard flag byte (see Tech Ref Man, p. A-2)
data      ends

cseg      segment
assume    cs:cseg,ds:data

dvorak    db        ?              ;Dvorak flag
          org       100h

start:    mov       dx, 5Ch        ;Set DS:DX to loc. 5CH in program prefix
          mov       al,9           ;Set the keyboard interrupt (INT 9)
          mov       ah,25h         ; to DS:DX via DOS function call
          int       21h
          mov       di,dx          ;Move keyboard routine down so it starts
          mov       si,keyadr      ; at loc. 5CH in program prefix
          mov       cx,keylen      ; (saves space)
          jmp       finish

;Keyboard interrupt routine.  Copy beginning of IBM PC ROM routine to
;allow easy jump to later ROM code

keybrd:   push      ax             ;Save registers used
          push      bx
          push      cx
          push      dx
          push      si
          push      di
          push      ds
          push      es
          cld
          mov       ax,data
          mov       ds,ax
          sti
          in        al,kb_data     ;Get key code
          push      ax
          in        al,kb_ctl      ;Restore keyboard
          mov       ah,al
          or        al,80h
          out       kb_ctl,al
          xchg      ah,al
          out       kb_ctl,al
          pop       ax
          mov       ah,al          ;Save key code

;End of copied ROM code. Start special translations

          cmp       al,0ffh        ;Overrun?
          jz        romkey

          mov       di,tabadr      ;Translate key code
          cmp       cs:dvorak,28   ;Use Dvorak table?
          jnz       keybr0
          mov       di,tabddr      ;Yep
keybr0:   and       al,7fh         ;Kill make/break bit
          call      trans
          test      ah,80h         ;Break code?
          jnz       romky0

          test      kb_flag,4      ;No. Ctrl key pressed?
          mov       di,ctadr
          jz        altran
          cmp       al,28          ;Yep. Enter key? (Use Dvorak?)
          jz        keybr2
keybr1:   cmp       al,1           ;Escape key? (Leave Dvorak?)
          jnz       tran
keybr2:   mov       cs:dvorak,al
          jmp       far ptr k26    ;Restore regs and reti

altran:   test      kb_flag,8      ;Alt key pressed?
          jz        romkey
          mov       di,oaltlc
          test      kb_flag,43h    ;Shift?
          jz        tran
          mov       di,oaltuc

tran:     call      trans
          jnz       romkey
          jmp       far ptr k61

romky0:   or        al,80h
romkey:   mov       ah,al
          jmp       far ptr romadr

;Translate routine.  Replaces byte in string [di] by byte following
;matched byte.  Returns Z if no match found; NZ if match found.

trans:    cmp       al,cs:[di]
          jz        xfnd
          inc       di
          inc       di
          cmp       byte ptr cs:[di],0
          jnz       trans
          or        al,al
          ret                      ;RNZ
xfnd:     mov       al,cs:1[di]
          ret                      ;RZ
```

Listing 1 continued on page 405

Listing 1 continued:

```
finish:   rep      movsb
          mov      dx,di         ;End program but leave keybrd resident
          int      27h

table     db       43,42,74,43,0 ;backslash -> left shift, keypad- -> backslash

;For a Dvorak keyboard use

tabled    db       16,40,17,51,18,52,19,25,20,21,21,33,22,34,23,46,24,19,25,38,26,53
          db       30,30,31,24,32,18,33,22,34,23,35,32,36,35,37,20,38,49,39,31,40,12
          db       44,39,45,16,46,36,47,37,48,45,49,48,50,50,51,17,52,47,53,44,0

ctable    db       15,15,72,21   ;©backtab -> ©O, ©uparrow -> ©U
          db       80,10,0       ;©downarrow -> ©J

altlc     db       30,132,46,135,18,130,49,164,24,148,22,129,23,161,51,174,52,175
          db       02,173,53,168,03,253,13,240,32,235,0
altuc     db       30,142,46,128,18,138,49,165,24,153,22,154,02,173,53,168,05,156
          db       41,247,13,241,32,127,0
keyend:

cseg      ends

rom       segment  at 0f000h     ;IBM ROM BIOS keyboard entry points
          assume   cs:rom
          org      0e9a8h
romadr    label    far           ;Perform all but initial processing
          org      0ea5eh
k26       label    far           ;Restore registers and return
          org      0ea81h
k1234     label    far           ;Reboot (Ctrl-Alt-Del addr)
          org      0ec0ch
k61       label    far           ;Store char in keyboard buffer and return
rom       ends

keyadr    equ      (offset keybrd - offset start) + 100h
keylen    equ      offset keyend - offset keybrd
tabadr    equ      (offset table - offset keybrd) + 5Ch
tabddr    equ      (offset tabled- offset keybrd) +5Ch
ctadr     equ      (offset ctable- offset keybrd) +5Ch
oaltlc    equ      (offset altlc - offset keybrd) + 5Ch
oaltuc    equ      (offset altuc - offset keybrd) +5Ch

          end      start
```

Listing 2: *KYBRD is a program to convert IBM PC keyboard codes, given by call to KEYR, into extended ASCII codes (returned in A with extension code in C). Standard keys work as they do for regular ASCII, with ASCII code returned in A and C equal to 0. If the Alt key is pressed, bit 7 of A is set. Special-function keys, TAB, BS, CR, and cursor-pad keys return a code in A (the ASCII code if relevant) with C equal to hexadecimal FE for TAB, BS and CR, and C equal to hexadecimal FF for all others. For these special keys, pressing Alt sets bit 7 of A, pressing Ctrl sets bit 6 of A, and pressing the shift key sets bit 5 (so that the numeric keypad works reasonably). The program includes the routines (starting with KEYR) to time the keyboard waveforms using a TRS-80 (printer-port pin 28). For practical use, one should use a UART to read the keyboard and preferably incorporate KYBRD as part of an interrupt-handling routine.*

```
.Z80
.radix    16

.comment ¶KYBRD is a program to convert IBM PC keyboard codes given by call to KEYR
into extended ASCII codes (returned in A with extension code in C).  Standard keys work as
for regular ASCII, with ASCII code returned in A and C=0.  If the Alt key is depressed, bit
7 of A is set.  Special function keys, TAB, BS, CR, and cursor pad keys return a code in A
(the ASCII code if relevant) with C=0feh for TAB, BS, and CR, and C=0ffh for all others.
For these special keys, Alt depressed sets bit 7 of A, Ctrl depressed sets bit 6 of A, and
SHFT depressed sets bit 5 (so that numeric keypad works reasonably).  The program below
includes the routines (starting with KEYR) to time the keyboard waveforms using a TRS-80
(printer port pin 28).  For practical use, one should use a UART to read the keyboard and
preferably incorporate KYBRD as part of an interrupt handling routine.
¶

;Test program

START:    xor      a             ;Turn off shift bits
          ld       (SHIFT),a
LOOP:     call     KYBRD         ;Get next character
          or       c             ;Test for null in c
          jr       z,LOOP3       ;Display char alone if c=0
          inc      c
          ld       c,'$'         ;0ffh codes are displayed following '$'
          jr       z,LOOP2
          ld       c,'#'         ;0feh codes are displayed following '#'
LOOP2:    push     af
          call     co
          pop      af
LOOP3:    ld       c,a
          call     co
          jr       LOOP          ;Continue

;Main decode routine

KYBRD:    call     KEYR          ;Get next code
          ld       c,a           ;Save it
          or       a
          ret      z
          res      7,a           ;Turn off break bit
          ld       hl,TAB1-1     ;Point to TABLE1
          ld       d,0           ;Clear d
```

Listing 2 continued on page 406

Listing 2 continued:

```
        ld      e,a
        add     hl,de           ;Index table
        ld      a,(hl)          ;Get ASCII code
        ld      e,a             ;Save key code

        ld      hl,SHIFT        ;Check for shift keys
        cp      83              ;Alt key?
        ld      b,80
        jr      z,SHF
        cp      82              ;Ctrl key?
        ld      b,40
        jr      z,SHF
        cp      81              ;Left SHIFT key?
        ld      b,2
        jr      z,SHF
        cp      80              ;Right SHIFT key?
        ld      b,4
        jr      z,SHF

        bit     7,c             ;Ignore break codes for shift locks
        jr      nz,RET3         ; and all non-shift codes

        cp      84              ;NumLock key?
        ld      b,20
        jr      z,SHFL
        cp      85              ;CapsLock key?
        ld      b,1
        jr      z,SHFL

;Process non-shift keys

        cp      1f              ;Special char?
        jr      c,SPEC
        cp      7b              ;No. Letter?
        jr      nc,OTHER
        cp      61
        jr      c,OTHER
        ld      a,(hl)          ;Yes. Check shifts
        bit     0,a             ;CapsLock?
        jr      z,KYBRD1
        and     6               ;Yep. Shift if neither shift key depressed
        ld      a,e
        jr      z,KYBRD2
        jr      RET
KYBRD1: and     6               ;No CapsLock. Shift key depressed?
        ld      a,e
        jr      z,RET
KYBRD2: res     5,a             ;Shift character
        jr      RET

OTHER:  ld      a,(hl)          ;Not letter, shift, or special
        and     6               ;Must be number or punctuation
        ld      a,e             ;Shift?
        jr      z,RET
        cp      60              ;Yep. '°'?
        jr      z,OTH2
        cp      5a              ;Test for code above uc letters
        jr      nc,OTH1         ;Go if above letter
        ld      hl,TAB2         ;Between ''' and '='. Point to shift table
        sub     '''             ;Move lowest code to zero
        jr      c,RET
        ld      d,0             ;Clear d
        ld      e,a             ;Put code in e
        add     hl,de           ;Index table
        ld      a,(hl)          ;Get shifted code
        jr      RET
OTH1:   set     5,a             ;Between 'Z' and 'a'
        jr      ret
OTH2:   ld      a,7e            ;Shift '°' to '™'

RET:    ld      c,0             ;Clear c (non-special char)
        ld      hl,SHIFT        ;Point to shift status
        bit     6,(hl)          ;Is Ctrl on?
        jr      z,RET1
        and     1f              ;Yep. Turn off bits 5 and 6

RET1:   bit     7,(hl)          ;Is Alt on?
        ret     z
        set     7,a             ;Yep. Turn on high bit
        ret

;Process shift keys

SHF:    bit     7,c             ;Test for break
SHF1:   ld      a,b
        jr      nz,SHFOFF       ;Reset shift bit if break code
        or      (hl)            ;Set shift bit
SHF2:   ld      (hl),a          ;Update shift bits
RET3:   xor     a               ;Return a=0
        ret
SHFOFF: cpl
        and     (hl)            ;Turn shift bit off
        jr      SHF2            ;Go update

SHFL:   ld      a,b             ;Toggle SHIFT Lock keys. Load bit into a
        and     (hl)            ;Check bit in shift memory
        jr      SHF1

;Process function and cursor pad keys

SPEC:   cp      11              ;NumLockable key (digit)?
        ld      a,(hl)          ;Get shift codes
        jr      c,SPEC0
        bit     5,a             ;Yep. NumLock on?
        jr      z,SPEC0
        and     6               ;Yep. Shift?
        ld      a,e
        jr      nz,SPEC2
        jr      SPEC1           ;No. Convert to number
SPEC0:  and     6               ;No NumLock. Shift?
```

Listing 2 continued on page 407

Listing 2 continued:

```
            ld      a,e
            jr      z,SPEC2
SPEC1:      set     5,a             ;Yep. Convert to number
SPEC2:      bit     6,(hl)          ;Ctrl on?
            jr      z,SPEC3
            set     6,a             ;Yep. Set control bit in code
SPEC3:      ld      e,a             ;Save code
            ld      a,c
            ld      c,0feh          ;Load return code for TAB, BS, and CR
            cp      0e              ;BS?
            jr      z,SPEC4
            cp      0f              ;TAB?
            jr      z,SPEC4
            cp      1c              ;CR?
            jr      z,SPEC4
            inc     c               ;0ffh is return code for all others
SPEC4:      ld      a,e
            jr      RET1            ;Choose Alt bit and return

;TRS-80 waveform decode programs

DATA        equ     0f8             ;Input port of keyboard (printer handshake port
                                    ; on TRS-80)

KEYR:       in      a,(DATA)        ;Get keyboard byte
            bit     7,a             ;Is bit keyboard bit high (Change this bit check to
                                    ;the bit you are inputing the keyboard signal on)
            jr      nz,KEYR         ;Try again if not high
            di                      ;Disable interrupts
            ld      b,22
STALL:      djnz    STALL           ;Stall until next bit is ready
            ld      c,6
            ld      b,8
GETIT:      in      a,(DATA)        ;Get bit
            rla                     ;Shift into carry
            rr      c               ;Shift carry into c
            call    DELAY           ;Delay until next bit is ready
            djnz    GETIT           ;Read 8 bits
            ld      a,c             ;Put code in a
            cpl
            ei                      ;Reenable interrupts
            ret

co:         ret                     ;Console display routine

DELAY:      ld      a,b
DELAY0:     dec     a               ;Delay for 1 bit period
            jr      nz,DELAY0
            ret

SHIFT:      db      1               ;Shift byte: B0=CapsLock, B1=SHIFT, B2=SHIFT
                                    ;B3= , B4= , B5=Ctrl, B6=NumLock, B7=Alt
```

.comment ¶**Key code translation table.** Translates ASCII characters into ASCII, shift characters into codes 80-84 and special characters into codes 1-19H. These codes are further processed by the program. Key changes can be made by substituting desired translated codes for those in table. The appropriate table rows for the Dvorak keyboard are given as comments following the table.
¶

```
TAB1:               ;For key code value, add units and decade
;Key code units:     0  1  2  3  4  5  6  7  8  9
;                     Esc 1  2  3  4  5  6  7  8
            db       1b,31,32,33,34,35,36,37,38      ;00 (Code decade)
;                    9  0  -  = BS TB  q  w  e  r
            db      39,30,2d,3d,08,09,71,77,65,72    ;10
;                    t  y  u  i  o  p  [  ] CR Ctrl
            db      74,79,75,69,6f,70,5b,5d,0d,82    ;20
;                    a  s  d  f  g  h  j  k  l  ;
            db      61,73,64,66,67,68,6a,6b,6c,3b    ;30
;                    '  ° SH  ®  z  x  c  v  b  n
            db      27,60,81,5c,7a,78,63,76,62,6e    ;40
;                    m  ,  .  / SH PS AL    CL F1
            db      6d,2c,2e,2f,80,0f,83,20,85,01    ;50
;                   F2 F3 F4 F5 F6 F7 F8 F9 F0 NL
            db      02,03,04,05,06,07,08,09,0a,84    ;60
;                   SL K7 K8 K9 K- K4 K5 K6 K+ K1
            db      0c,17,18,19,0d,14,15,16,0b,11    ;70
;                   K2 K3 K0 Del
            db      12,13,10,0e                      ;80
```

.comment ¶The **Dvorak keyboard** is given by substituting the following lines for the corresponding lines above (identified by the decade code at the end of each line)

```
;                    9  0  -  = BS TB  '  ,  .  p
            db      39,30,2d 3d,08,09,27,2c,2e,70    ;10
;                    y  f  g  c  r  l  /  [ CR Ctrl
            db      79,66,67,63,72,6c,2f,5b,0d,82    ;20
;                    a  o  e  u  i  d  h  t  n  s
            db      61,6f,65,75,69,64,68,74,6e,73    ;30
;                    ]  ° SH  ®  ;  q  j  k  x  b
            db      5d,60,81,7a,3b,71,6a,6b,78,62    ;40
;                    m  w  v  z SH PS AL    CL F1
            db      6d,77,76,7a,80,0f,83,20,85,01    ;50
```

Shift table for punctuation and numbers follows
¶

```
;                    '  (  )  *  +  ,  -  .  /  0    ; Char to be shifted
TAB2:       db      22,00,00,00,00,3c,5f,3e,3f,29    ; Shifts codes 27H
                                                     ('"')
;                    1  2  3  4  5  6  7  8  9  :    ; to 3dH ('=')
            db      21,40,23,24,25,36,26,2a,28,00
;                    ;  <  =
            db      3a,00,2b

            end     START
```

Text continued from page 403:
occur more than 75 percent of the time in English text, this arrangement contributes to very efficient typing.) Entering a Ctrl-Esc combination returns you to the initial mode, so you can switch back and forth at any time. See figures 1a and 1b for a comparison of these two keyboard layouts.

You can also assign alternate values for a number of keys. For example, the alternates for A, O, and U are Ä, Ö, and Ü. Similar translations are made for Spanish and French characters. The choices are dependent on values stored in the program, and so require a little work to change, but the program does show how to modify the keyboard output. In our technical word-processing system, we assign alternates that correspond to the characters on the IBM Selectric symbol type ball. Along with a screen character-generator change, this allows you to edit mathematical text on screen. The program takes over the keyboard interrupt (number 17) accessed by PC DOS. Hence all standard software receives character codes set up by the routine (this method is very powerful). See the references for detailed information on these techniques.

Encoding

With this overview in mind, let's

(1a)

Q W E R T Y U I O P
A S D F G H J K L ; '
\ Z X C V B N M , . /

(1b)

, . P Y F G C R L /
A O E U I D H T N S
; Q J K X B M W V Z

Figure 1: *Comparison of the standard layout (1a) and the Dvorak layout (1b) on the IBM Personal Computer.*

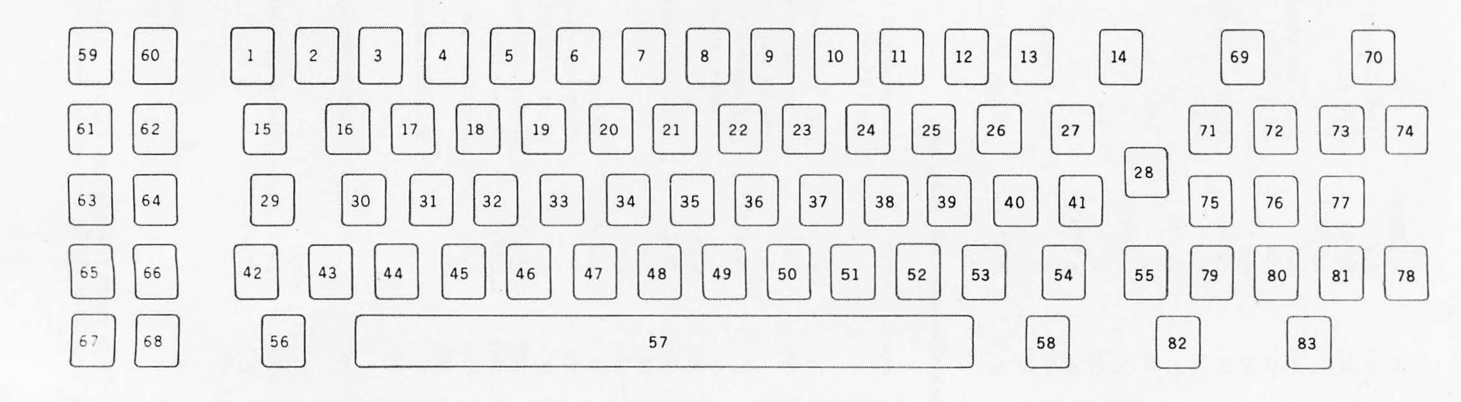


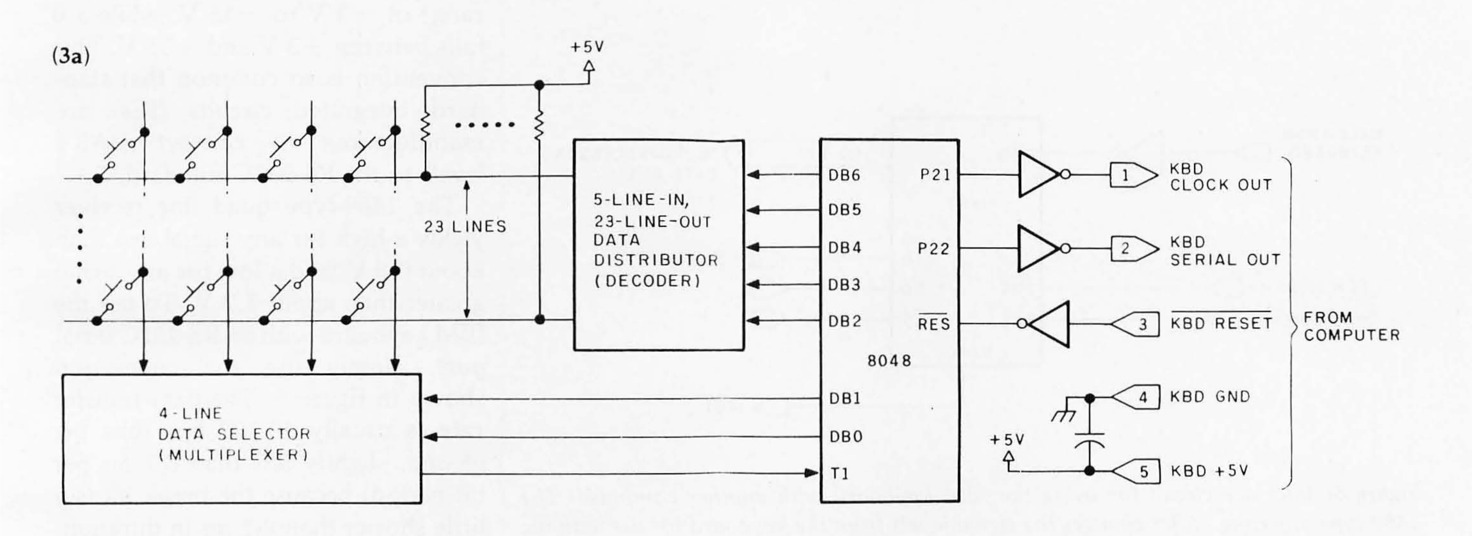
Figure 2: *Make codes, expressed in decimal. When a key contact is made, the keyboard transmits the corresponding code serially as an 8-bit binary number. The same code, but with the high bit set to 1, is sent when a contact is broken.*

now consider the encoding scheme in detail. Figure 2 shows the decimal values of each key's make code. The corresponding code when the key closure is broken (break code) is the same code plus 128. In binary, this corresponds to setting the high-order bit of a byte to 1.

Internally the keyboard generates this bit stream using the Intel 8048 as diagrammed in figure 3a. Five output bits from the 8048 cause a data-distributor circuit to pull one of 23 normally high lines to a low level. A particular key connects one of these lines to one of four interrogation lines that run to a data-selector circuit read by the 8048. The 8048 scans the keyboard-switch array by continually checking the four lines one at a time to see if any are low. When it finds a closure, it waits a few milliseconds (ms) to let the contacts stop bouncing. The 8048 then stores the make code in a buffer for transmission to the remote computer.

Similarly, if the 8048 notices that a key closure is broken, it stores the break code. The codes are sent out serially as described above. The 8048 also automatically repeats any key that remains down for longer than ½ second. The circuit in figure 3a includes a clock output line used by the IBM Personal Computer interface, reproduced in figure 3b, and an input

(3a)



(3b)

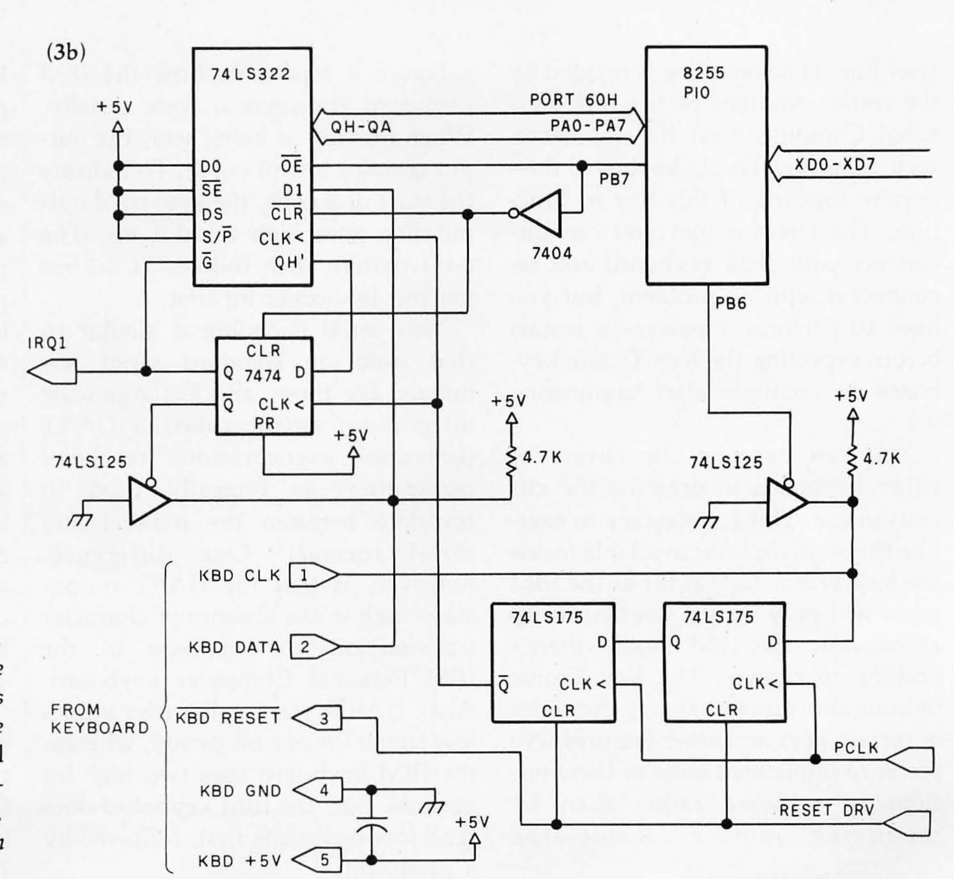


Figure 3: *Interface circuitry used by IBM. Figure 3a is a partial diagram of the transmission circuitry used by IBM in its keyboard, as shown on page D-12 of the* IBM Personal Computer Technical Reference Manual. *The Personal Computer's keyboard input-port interface, from page D-10 of the manual, is shown in figure 3b.*

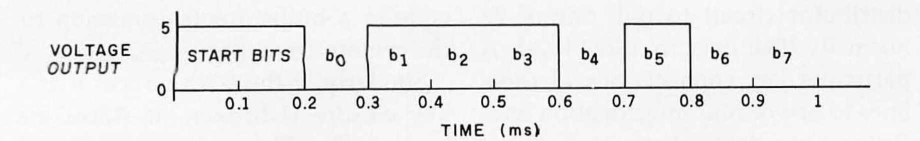


Figure 4: *Diagram of the serial bit stream generated by the IBM PC keyboard when a key is pressed. The graph shows the voltage output (pin 2) versus time, starting when the C key (code 46 decimal, or 00101110 binary) is pressed. The voltage levels are TTL-compatible. In the absence of transmission, the keyboard sends a 0-V level. Two +5-V (high) "start bits" define the start of a character. Eight bits follow, each lasting 0.1 ms, except for the last, which is slightly shorter.*

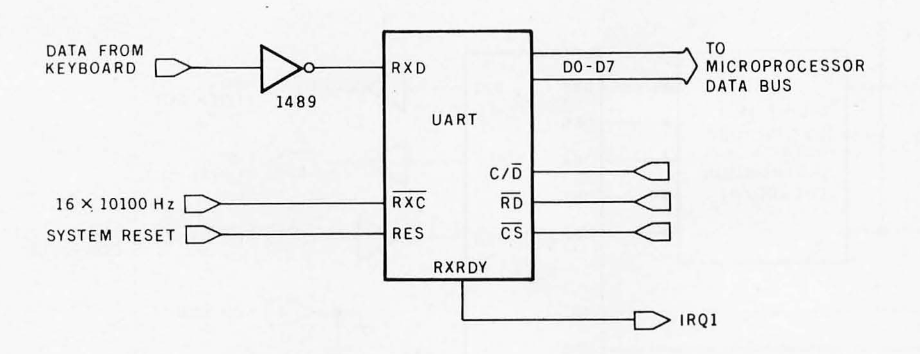


Figure 5: *Interface circuit for using the IBM keyboard with another computer. The 1489-type inverting buffer changes the signal levels from the keyboard for use with the UART, which then changes the serial data to parallel format.*

reset line. (The reset line is toggled by the restart routines of the IBM Personal Computer, but it's not necessary. The Key Tronic keyboard does require toggling of this line to function. The effect is that you can disconnect your IBM keyboard and reconnect it with no problem, but you have to perform a power-on restart before expecting the Key Tronic keyboard to continue after unplugging it.)

You can unscrew the covers of either keyboard to examine the circuits inside. This is necessary to exercise the many options available inside the Key Tronic but, as far as the IBM goes, will only satisfy your curiosity about how the IBM looks—there's nothing to change. The Key Tronic options allow interchanging the codes of certain keys and other features. We prefer to implement most of these options in software rather than by modifying jumpers inside the enclosure.

Figure 4 represents how the IBM keyboard transmits a code serially. When no code is being sent, the output remains low (0 volts). To indicate the start of a code, the keyboard output line goes high for 0.2 ms. The 8-bit pattern then follows at 0.1 ms per bit, low-order bit first.

This serial encoding is similar to that used on standard serial terminals. For these, an LSI (large-scale integration) circuit called a UART (universal asynchronous receiver/transmitter) is typically used to translate between the parallel and serial formats. One difference, however, is that the UART output stays high in the absence of character transmission—the opposite of the IBM Personal Computer keyboard. Also, UARTs start a character with a low signal for one bit period, whereas the IBM keyboard uses two high bit periods. But the IBM keyboard does send low-order bits first, followed by a parity bit.

Interfacing to Other Hardware

Fortunately, you can easily take care of these differences. Although IBM did not choose to do so, the serial output of the keyboard can be read using a UART, provided you invert the signal. The keyboard's output is, in fact, very close to the EIA's (Electronic Industries Association) RS-232C voltage convention; effectively, the voltage polarity of the bit stream is inverted by this convention: a 1 is represented by a signal in the range of −3 V to −15 V, while a 0 falls between +3 V and +15 V. This convention is so common that standard integrated circuits (ICs) are manufactured to convert UART levels to the RS-232C standard.

The 1489-type quad line receiver yields a high for any signal less than about 0.8 V, and a low for any signal greater than about 1.7 V. To use the IBM keyboard with an RS-232C serial port, simply use the connection shown in figure 5. The data-transfer rate is usually 10,100 bps (bits per second, slightly less than 0.1 ms per bit period) because the break bit is a little shorter than 0.1 ms in duration. Except for the breaks, 9600 bps would work fine.

The next problem is that the "start bit" from the IBM keyboard is 2 bit periods long (hence you must disregard what the UART perceives as the low-order bit). Meanwhile, 8 significant bits follow, but the UART accepts only as many as 8 bits plus a parity bit, so we've developed the program in listing 3. It ignores the low-order bit, shifts all the more significant bits down one place, and replaces the high-order bit with the parity bit. (You can run this program and use a standard IBM serial port with the data rate set to 10,100 bps, but be very careful not to plug the output of the keyboard directly into an RS-232C line, or you'll destroy the output driver.) This method can also be used for the Key Tronic keyboard, which uses a data rate of 30,000 bps.

Other methods of reading the serial stream come to mind. You can copy the circuit used in the IBM Personal Computer itself, since it's published in the *IBM Personal Computer Technical Reference Manual* on page

D-10. This manual is a must for working with the keyboard because it gives the internal schematic of the keyboard. Figure 3b shows this circuitry but includes only those lines and integrated circuits that pertain to keyboard functions. (One advantage to using a UART is that it can communicate directly on a computer system's bus and requires no intervening parallel-port hardware.)

Very quickly, the operation of the circuit is as follows: The KBD CLK clock line from the keyboard is delayed two system clock periods and inverted by the pair of 74LS175 latches. This new signal is used to shift the KBD DATA bits into the

The bit stream is quite simple and can be decoded directly.

74LS322 serial-parallel shift register. When 8 bits have been shifted in, the 74LS322 carry is latched to provide an interrupt on the IRQ1 line. This calls IBM's INT 9 interrupt handler to read the character through the 8255 parallel input/output (I/O) circuit and to clear the interrupt. No data rate needs to be specified because the data is shifted in synchronously with the KBD CLK generated by the keyboard 8048 microprocessor.

Because the bit stream is quite simple, it can also be decoded directly using a single input line of a parallel port. To do this successfully, the computer must begin reading immediately after the start bit is sent. To avoid wasting time waiting for start bits, the rising edge of the start bit should be used to interrupt the computer. This interrupt should have the highest priority of all interrupts and require that the other interrupts be disabled for the 1 ms required for decoding the bit stream. (Such an interrupt-driven scheme is not undesirable; keyboards are substantially more powerful when interrupt driven, as described in references 1 and 2. In particular, you don't lose

Listing 3: *UART decode program.*

```
title   rs232 decoder
.z80
.radix  16

STATUS  equ     1           ;Status port of UART
DATA    equu    0           ;Data port of UART

CI:     in      a,(STATUS)      ;Get status of UART
        ld      b,a         ;Put status byte into b
        and     2           ;Is a character waiting
        jr      z,CI        ;Wait if no character
        ld      a,37
        out     (STATUS),a      ;Clear status port
        in      a,(DATA)        ;Get character
        or      a
        jp      e,EVEN      ;Go if even parity in a
        bit     3,b         ;Check for a parity error
        jr      nz,CONT     ;Go if no error
        jr      STC         ;Go if error
EVEN:   bit     3,b         ;Check for parity error
        jr      z,CONT      ;Go if no error
STC:    scf                 ;Set carry
CONT:   rra                 ;Rotate carry into high bit of character
        cpl                 ;Complement a
        push    af          ;Save character
        ld      e,37
        out     (STATUS),a      ;Clear status
        pop     af          ;Get character back
        ret
        end
```

Listing 4: *Parallel-bit decode subroutine.*

```
DATA    equ     7           ;Port being used

WAIT:   in      a,(DATA)        ;Input from port
        bit     2,a         ;Is input bit high
        jr      z,WAIT      ;Wait if not high
        di                  ;Disable interrupts. If interrupt-
        ld      b,38        ; driven, this is already done
STALL:  djnz    STALL       ;Stall through two start bits
        ld      c,6
        ld      b,8         ;Number of bits
GETIT:  in      a,(DATA)        ;Input bit
        rra                 ;Rotate into carry
        rra                 ;Use one rra for input bit zero
        rra                 ;Two for input bit one, etc.
        rr      c
        call    DELAY       ;Stall until next bit is ready
        djnz    GETIT       ;Continue until all 8 bits received
        ld      a,c         ;Put character into a
        ret
DELAY:  ld      a,8         ;Delay, ld a with 8 for 4 MHZ clock
DELAY0: dec     a
        jr      nz,DELAY0
        ei
        ret
        end
```

(6a)

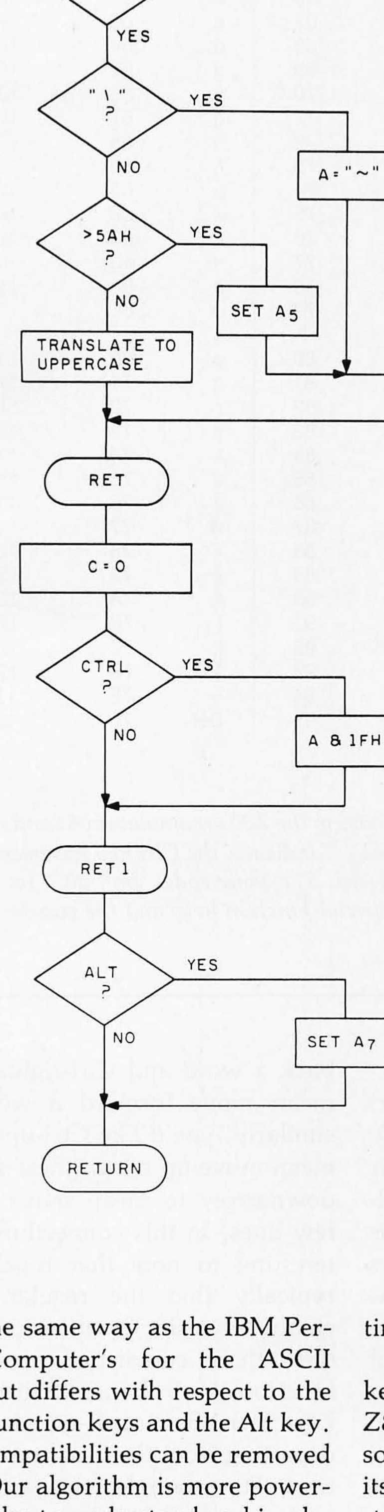
Figure 6: *Flowchart of complete keyboard-encoder program shown in listing 2.*

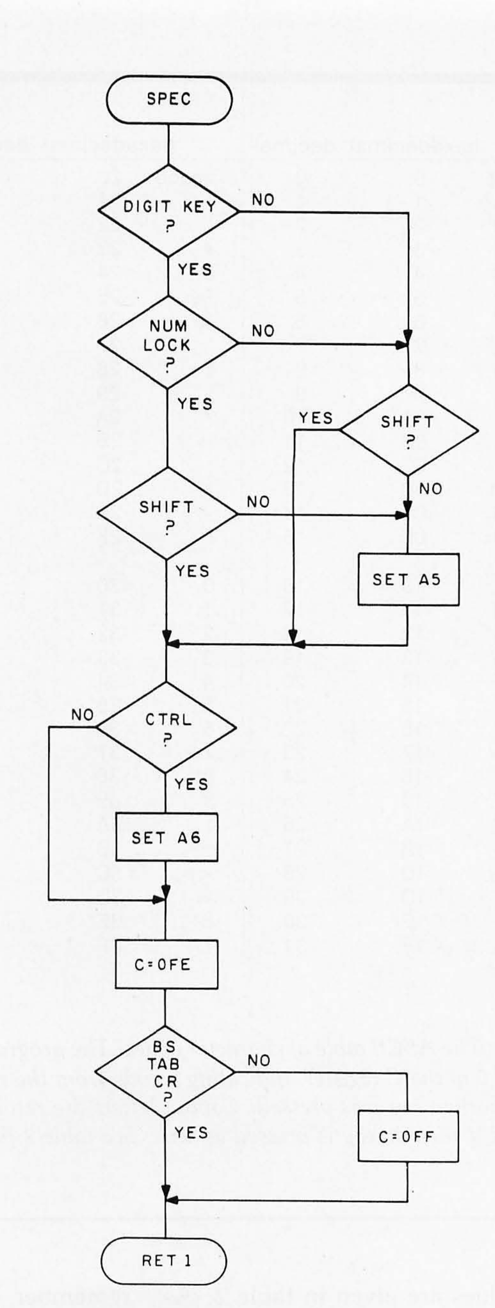
characters when you type faster than a program can process, and you can stop a program gone haywire to examine things with a machine-language monitor.) The IBM Personal Computer itself has several hardware interrupts, including the one for the keyboard, and is all the more powerful because of them. A program to decode the serial stream is shown in listing 4.

Interfacing to Other Software

To perform truly useful functions, you must translate the complete set of make codes and break codes into the standard ASCII codes and useful extensions. Our translation scheme







works the same way as the IBM Personal Computer's for the ASCII subset but differs with respect to the special-function keys and the Alt key. The incompatibilities can be removed easily. Our algorithm is more powerful, simpler to understand and implement than IBM's, and one third as long. In any event, it illustrates how one can go about translations in general. IBM's program is published for the Intel 8086 microprocessor in the technical reference manual starting on page A-24.

Figure 6 shows the flowchart for a keyboard translator written for the Z80 microprocessor using the Microsoft M80 assembler. (The program itself is given in listing 2.) The 128 standard ASCII codes are returned in the accumulator (the A register) with values given in table 1. If the Alt key is pressed when one of these codes is deciphered, bit 7 of the accumulator is set to 1. This immediately produces an alternate set of codes that round out the 256 possibilities available with 8 bits. We often make the alternate set correspond to a second daisy wheel for printing mathematical documents. The alternate set plays the role of the IBM Selectric symbol ball, but other uses abound.

These 256 standard-key codes are returned in register A with a value of 0 in register C. The codes returned by the special-function and cursor-pad keys are also returned in A but with register C equal to hexadecimal 0FF.

	hexadecimal	decimal		hexadecimal	decimal		hexadecimal	decimal		hexadecimal	decimal
^@	0	0	space	20	32	@	40	64	`	60	96
^A	1	1	!	21	33	A	41	65	a	61	97
^B	2	2	"	22	34	B	42	66	b	62	98
^C	3	3	#	23	35	C	43	67	c	63	99
^D	4	4	$	24	36	D	44	68	d	64	100
^E	5	5	%	25	37	E	45	69	e	65	101
^F	6	6	&	26	38	F	46	70	f	66	102
^G	7	7	'	27	39	G	47	71	g	67	103
^H	8	8	(	28	40	H	48	72	h	68	104
^I	9	9	)	29	41	I	49	73	i	69	105
^J	0A	10	*	2A	42	J	4A	74	j	6A	106
^K	0B	11	+	2B	43	K	4B	75	k	6B	107
^L	0C	12	,	2C	44	L	4C	76	l	6C	108
^M	0D	13	–	2D	45	M	4D	77	m	6D	109
^N	0E	14	.	2E	46	N	4E	78	n	6E	110
^O	0F	15	/	2F	47	O	4F	79	o	6F	111
^P	10	16	0	30	48	P	50	80	p	70	112
^Q	11	17	1	31	49	Q	51	81	q	71	113
^R	12	18	2	32	50	R	52	82	r	72	114
^S	13	19	3	33	51	S	53	83	s	73	115
^T	14	20	4	34	52	T	54	84	t	74	116
^U	15	21	5	35	53	U	55	85	u	75	117
^V	16	22	6	36	54	V	56	86	v	76	118
^W	17	23	7	37	55	W	57	87	w	77	119
^X	18	24	8	38	56	X	58	88	x	78	120
^Y	19	25	9	39	57	Y	59	89	y	79	121
^Z	1A	26	:	3A	58	Z	5A	90	z	7A	122
^[	1B	27	;	3B	59	[	5B	91	{	7B	123
^\	1C	28	<	3C	60	\	5C	92	|	7C	124
^]	1D	29	=	3D	61	]	5D	93	}	7D	125
^^	1E	30	>	3E	62	^	5E	94	~	7E	126
^_	1F	31	?	3F	63	_	5F	95	Del	7F	127

Table 1: *The ASCII table of character codes. The program in listing 2 returns these codes in the Z80 accumulator (A) and returns a value of 0 in the C register, indicating a code from the regular keyboard. The symbol "^" indicates the Ctrl key has been pressed while another key was pressed. Capital letters are returned when a shift key is pressed. The same codes with bit 7 set to 1 are returned if the Alt key is pressed as well. See table 2 for codes returned from the special-function keys and the cursor/numeric keypad.*

Their values are given in table 2. As for the codes in table 1, if the Alt key is depressed, bit 7 of the code is set to 1. The shift and Ctrl keys set bit 5 and bit 6, respectively. This somewhat strange (relative to ASCII) choice was made so that the codes correspond to their names. For example, the numeric keypad's numeral keys should return their ASCII codes when the shift key is depressed, in contrast to their counterparts on the typewriter portion of the keyboard, which return the ASCII codes while unshifted.

The special-function keys F1 through F10 correspond to codes 1 through hexadecimal 0A (decimal 10), and the numerals 0 through 9 correspond to codes hexadecimal 10 through 19, allowing you to remember them easily. The backspace, tab, and carriage-return (enter) keys give the values 8, 9, and D, respectively; but, unlike their counterparts Ctrl-H, Ctrl-I, and Ctrl-M, the value hexadecimal 0FE is returned in the C register. This allows you to distinguish between the control characters, the function keys, and these special keys—a very useful feature for word-processing systems.

Because any combination of Ctrl, shift, and Alt keys are returned along with the special keys, many combinations are available for word processing and other applications. In particular, the software used by the IBM Personal Computer doesn't return anything for Ctrl-uparrow. This is too bad because text editors typically use Ctrl-leftarrow to mean move back a word and Ctrl-rightarrow to mean move forward a word, and similarly, you'd like Ctrl-uparrow to mean move up a few lines, and Ctrl-downarrow to mean move down a few lines. In this connection, it's interesting to note that touch-typists typically find the regular control characters easier to use for cursor motion than cursor-pad or special-function keys because the regular keys can be touch-typed without departing from the usual typing position. For example, this article was written using the super Pmate context/screen editor, which fully supports both the regular control characters and all IBM's special keys. However, we seldom use the special keys because they require looking at the keyboard.

Key	Value	Shift value	Ctrl value	Alt value
	00	20	40	80
F1	01	21	41	81
F2	02	22	42	82
F3	03	23	43	83
F4	04	24	44	84
F5	05	25	45	85
F6	06	26	46	86
F7	07	27	47	87
F8	08	28	48	88
F9	09	29	49	89
F10	0A	2A	4A	8A
+	0B	2B	4B	8B
Scroll Lock	0C	2C	4C	8C
−	0D	2D	4D	8D
	0E	2E	4E	8E
*	0F	2F	4F	8F
0	10	30	50	90
1	11	31	51	91
2	12	32	52	92
3	13	33	53	93
4	14	34	54	94
5	15	35	55	95
6	16	36	56	96
7	17	37	57	97
8	18	38	58	98
9	19	39	59	99
	1A	3A	5A	9A
	1B	3B	5B	9B
	1C	3C	5C	9C
	1D	3D	5D	9D
	1E	3E	5E	9E
BS	08	28	48	88
TAB	09	29	49	89
CR	0D	2D	4D	8D

Table 2: *Hexadecimal key values returned in register A for special-function and cursor/numeric keys with no shift keys pressed, or one alone. Additional combinations can be made by pressing two or three shift keys simultaneously, e.g., shift-Ctrl-F1 yields 61. Shift sets bit 5, Ctrl sets bit 6, and Alt sets bit 7. Register C returns with hexadecimal 0FF for all combinations except BS, TAB, and CR, for which C equals hexadecimal 0FE (so as not to be identical to F8, F9, and −). BS stands for backarrow, and CR stands for carriage return. Note that codes returned in A for keys like the regular keyboard keys (e.g., the shifted digits 0 through 9) are the same as the ASCII values. The value in register C allows the user to differentiate between these codes.*

Finishing Up

We've described the aesthetic and practical features of the IBM Personal Computer keyboard, showing how the keyboard both looks and acts like the leader in the field. We've shown how you can tailor the keyboard input driver to suit your needs, including an implementation of the Dvorak keyboard layout. The keyboard plays a significant role in making the IBM Personal Computer such a pleasure to use. With the simple interfacing described in this article, you can increase the pleasure of using other computers. ■

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2. For further discussion, see M. Sargent III and R. L. Shoemaker, *Interfacing Microcomputers to the Real World*. Reading, MA: Addison-Wesley, 1981.
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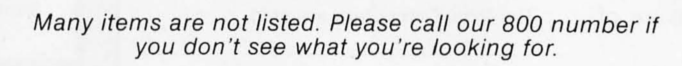
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Strongly Typed Languages

Ada, Pascal, and other new languages let you define your own data types

Earl E. McCoy
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In recent years, new programming languages have introduced the concept of strongly typed data—a novel idea for persons experienced in the earlier, weakly typed languages such as FORTRAN, COBOL, BASIC, and PL/I. This article explains the reasons behind the strongly typed concept and how it can be used to the programmer's advantage.

Background

All high-level programming languages define a set of basic data types, such as INTEGER or REAL, and operations appropriate for those types. A data type and the set of legal operations for that type have come to be known as a *data abstraction*. Abstraction is not used here in the sense of complex or difficult; it merely means the essential feature of a datum, such as the fact that it is an integer quantity. This is an extremely useful concept because it lets programmers concentrate on the problem at hand, rather than on the details of its solution.

First-generation languages such as FORTRAN, COBOL, and PL/I support useful and powerful data abstractions. In FORTRAN-77, for example, a character-string operation, say concatenation, cannot be legally applied to data of type REAL. If this were attempted, the compiler would indicate an error.

Many problems, however, can snare the unwary programmer. For example, the FORTRAN data abstractions for REAL and INTEGER types are ambiguous: they use the same symbols for most operations. Both types, for example, use the slash symbol (/) for division, but its meaning differs in each case. This results in the common error of 1 divided by 2 returning 0 when 0.5 was expected. An experienced programmer is aware of the problems resulting from poorly defined data abstractions and avoids them.

The problem with data abstraction in first-generation languages, however, goes even deeper. First-generation data types are too abstract. It is possible, for example, to add INTEGER variables, even though they represent different classes of objects, such as apples and oranges. Because the language does not recognize such concrete data types, it cannot warn the programmer when they are incorrectly combined. In listing 1, for example, a FORTRAN compiler cannot prevent the addition and assignment operations because it is not "apples" and "oranges" being summed, but rather integer values for which addition and assignment are legally defined. Note that in this values problem, FORTRAN would allow the identifiers to assume negative values, even though such values might be meaningless. Programmers are expected to recognize and avoid such illogical operations. The result is usually a longer and more tedious debugging phase than would otherwise be necessary.

A Solution

Problems such as these have led to the extension of the data-abstraction concept into a more powerful form in a new generation of strongly typed languages of which Pascal and Ada are representative examples. Developed as a teaching tool, Pascal is widely available and is used at most universities as the language of choice among computer science faculty and students. Ada, an extension and generalization of Pascal, was sponsored by the Department of Defense and is expected to attain wide use in both civilian and military applications. Ada is more strongly typed than Pascal; some examples discussed in this article apply only to Ada.

About the Author
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Listing 1: *Defining an integer identifier in FORTRAN.*

```
.
.
.
INTEGER apples, oranges, pears
.
.
pears = apples + oranges
.
.
```

Listing 2: *Ada allows a programmer to define new data types derived from built-in types.*

```
TYPE apples IS NEW INTEGER RANGE
  0..1000;
TYPE oranges IS NEW INTEGER RANGE
  0..1000;
redapples, greenapples, totalapples :
  apples;
florida, california : oranges;
.
.
totalapples : = redapples + greenapples;
  --legal
florida : = redapples + california; --illegal
```

Listing 3: *This Ada subprogram defines a data type for digital images and specifies valid operations for the new type.*

```
TYPE size IS NEW INTEGER RANGE
  0..255;
TYPE pixel IS NEW INTEGER RANGE
  0..63;
TYPE picture IS ARRAY (size, size) OF
  pixel;

frame1, frame2, frame3 : picture;
.
.
PROCEDURE contrast (a : IN picture, b :
  OUT picture);
.
END contrast;
PROCEDURE edgedetect (a : IN picture, b :
  OUT picture);
.
.
END edgedetect;
PROCEDURE brighten (a : IN picture, b :
  OUT picture);
.
END brighten;
.
.
```

A strongly typed language like Ada helps programmers avoid contextual logic errors by allowing them to define their own data types. The Ada program shown in listing 2, for example, uses the TYPE statement to define two new data types, "apples" and "oranges," which may have integer values ranging from 0 to 1000. Because both types are instances of the predefined type INTEGER, they inherit all the operations allowable for integers. Thus, all identifiers of the type "apples" may be added among themselves; so too may all identifiers of type "oranges." However, identifiers of type "apples" and type "oranges" may *not* be added together because they are of a different type. Identifiers of differing types may not be operated upon, even though they may be of the same underlying primitive type, as in this case. Thus, the data-abstraction concept provides a mechanism for enforcing logical correctness upon a program.

For this enforcement policy, a penalty must be paid in processing overhead. For instance, subrange values must be checked during program execution, which slows down the program somewhat. However, if the subrange check guarantees correct operation of the program, it's probably worth the price. Moreover, most type checking can be done at compile time, which exacts a small penalty for the benefit returned.

Programmers may avoid the overhead penalty. For example, in listing 2, a programmer could have avoided the subrange checking by not specifying a range in the TYPE statement. To eliminate the compile-time type check, the programmer could omit the TYPE statements entirely and simply declare the identifiers as integers, as is done in FORTRAN.

More Data Abstractions

In addition to inheriting operations from primitive data types, user-defined types can also specify new operations. This allows a programmer to define a data abstraction in the full sense of the term.

In an image-processing program, a programmer might want to operationally limit contrast enhance, edge detect, and brighten digitally encoded "pictures." In Ada, this may be accomplished by first defining a type "picture" in terms of more primitive types as shown in listing 3. Specifically, a picture datum is defined as a 256 by 256 array of picture elements (pixels), each having 64 possible gray levels.

Listing 4: *Ada's enumerated types make for more readable programs.*

```
TYPE automobile IS (ford, chevy, buick,
  datsun);
TYPE emissions IS (clean, dirty);
cars : ARRAY (automobile, emissions) OF
  INTEGER
air : emissions;
.
.
cars(ford, clean) : = cars(ford, clean) + 1;
.
```

The type "picture" does not inherit any of the operations valid for an array because it is defined (implicitly) as a private type (a special feature of Ada). Instead, the programmer defines the operations valid for picture data via the subprogram units shown in listing 3.

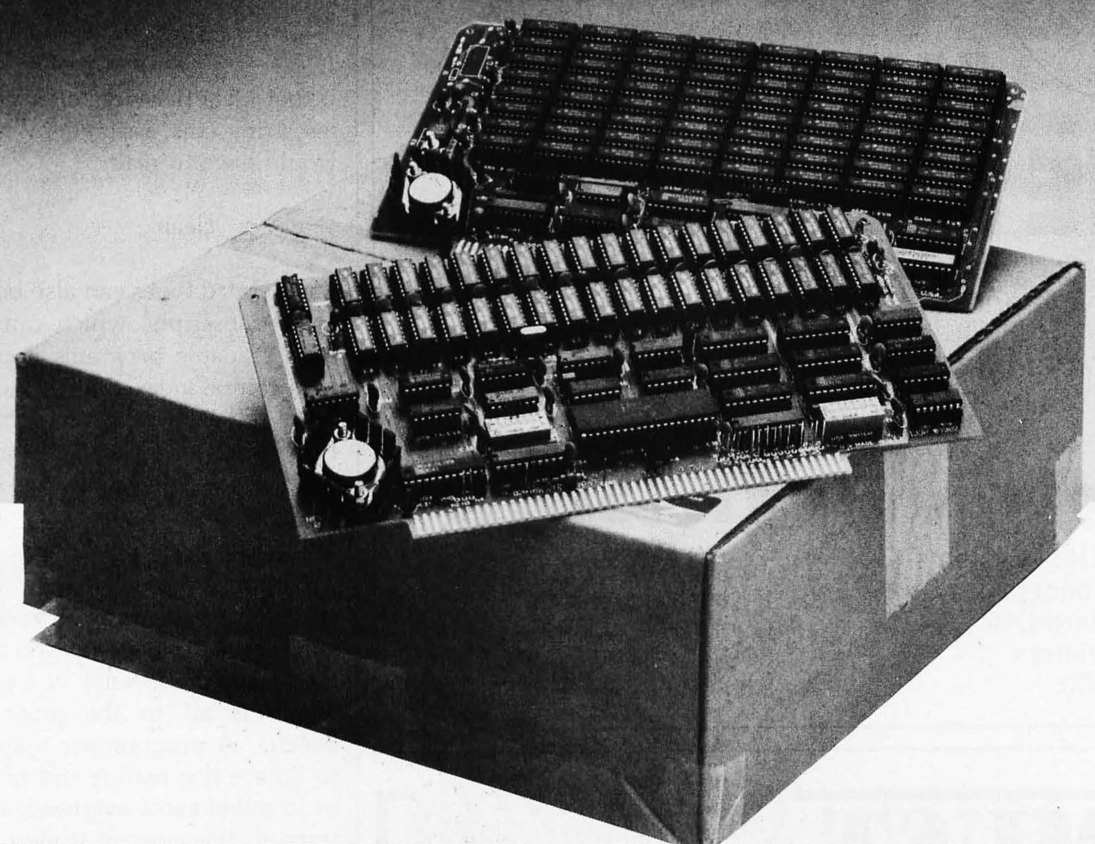
The advantage of user-defined data types is that they enable the computer to ensure that procedures process only data of the correct type. For example, defining a data structure as in listing 3 enables the computer to ensure that only pictures with the proper size, picture elements, and valid shades of gray are passed to the picture-processing procedures. Weakly typed languages can offer such protection only for predefined primitive data types.

New Primitive Data Types

Complementing the usual predefined primitive data types, such as INTEGER, CHARACTER, and REAL, Pascal and Ada have a new data type, called *scalar* in Pascal and *enumerated* in Ada.

Enumerated types make for more readable programs. Identifiers of this type may assume only those values listed by the programmer (see listing 4). The enumerated values may be

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strings of alphabetic characters but are not to be confused with character strings. In listing 4, the identifier "air" could be assigned a value by executing the following statement:

```
air := clean;
```

If that identifier were of type character string, the assignment statement would have to read:

```
air := "clean";
```

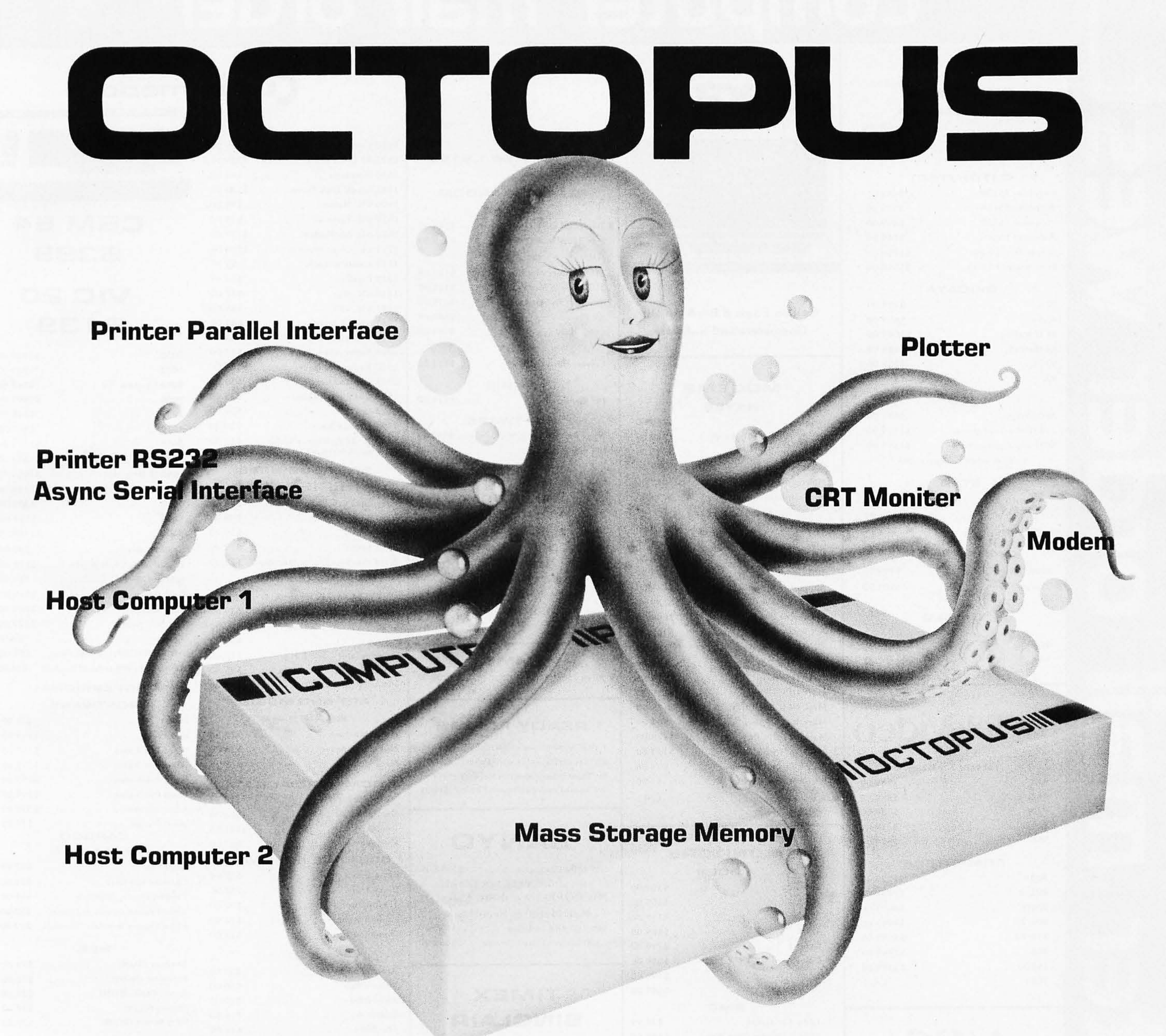
Enumerated types can also be used as array subscripts, which can lead to very readable programs because arrays can be indexed by names of objects rather than as integers, as in FORTRAN or COBOL. In addition, enumerated data can be used in CASE statements to make very readable multibranch tests.

In sum, the full-blown data-abstraction mechanisms of modern languages enable a computer to check the logical consistency of a program, which is all to the programmer's benefit. A programmer may choose to ignore this feature out of laziness or to avoid extra overhead. But once learned, this concept is easy and can help to produce error-free programs and ease maintenance of existing programs. ■

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Solarsoft
A Design Package for Solar Buildings

Winslow H. Fuller
Equinox Inc.
The Granite Block
Peterborough, NH 03458

Designing efficient passive solar residences and small office buildings is a complicated process. Although the basic principles of passive solar design are simple, their successful execution requires a thorough understanding of their physics and practical application. The four programs in the Solarsoft package enable the experienced architect/engineer or owner/builder to fine-tune the design of any passive solar building. The following is a review of the four programs.

Sunpas

Sunpas is an interactive program that can quickly estimate the auxiliary (or backup) heating requirement and solar contribution ("percent solar") of a passive solar building. The program uses monthly correlations developed at the Los Alamos Scientific Laboratory (LASL) in Albuquerque, New Mexico. This Solar Load Ratio method has become the standard estimation technique in the solar industry and is described in detail in the *Passive Solar Design Handbook*, vol. 2. (DOE/CS-0127/2), available from NTIS (National Technical Information Service), 5285 Port Royal Rd., Springfield, Virginia 22161.

The method uses the Solar Load Ratio (SLR) as the main parameter for estimating building performance. The SLR is the ratio of solar gains absorbed by a building in a given period of time (usually a month) to the heat lost during the same period. From this, the program calculates the Solar Savings Fraction (SSF), which yields the auxiliary heating requirement. The SSF is the building's "solar savings" divided by its "net reference thermal load." For most buildings, the net reference thermal load is the load on an equivalent building without the passive system, and thus the SSF is in fact the percent that the solar system contributes toward the heating of the building.

Sunpas is menu driven. A setup menu specifies the required input data, including building heat loss, internal heat gains, shading, and location information.

The "climate responsive takeoff" menu asks the user to define each building surface as to type (solar or nonsolar), area (width and height), and overall u-factor (heat-loss coefficient). If a surface is solar, the user must specify its azimuth and tilt, solar absorption, night insulation R-value (resistance, or measurement of the tendency of a material to retard the flow of heat), two key fixed shading overhang parameters, and one of five user-defined monthly shading patterns.

The "ground responsive" heat-loss menu allows the designer to specify heat loss with reference to a constant temperature source such as the earth—a nice feature. Although the heat-loss value may not be entirely accurate, it gives a good approximation of basement heat loss when the ground temperature is accurately estimated.

The "infiltration and perimeter" menu asks only for the total building volume and the average air infiltration rate in air changes per hour (AC/hr). The AC/hr value is important because it is generally a large part of the total heat loss. Average uninsulated houses have values approaching 1.0 AC/hr, while superinsulated houses are near 0.2 AC/hr. If there is a slab instead of a basement or crawl space, the perimeter heat loss can be defined in this menu section by the length of the exposed perimeter and a single heat-loss coefficient.

About the Author
Winslow H. Fuller is a licensed professional engineer and a principal in the architectural and engineering firm of Equinox Inc. in Peterborough, New Hampshire. He has analyzed hundreds of passive solar buildings for Equinox and for several state and national design competitions.

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At a Glance

Name
Sunpas, Sunop, Tswing, and Solgain

Type
Monthly SLR correlation method and economic analysis of passive solar buildings

Manufacturer
Solarsoft Inc.
POB 124
Snowmass, CO 81654
(303) 927-4411

Price
$700 for all four programs together; $395 for Sunpas and Sunop only; $395 for Tswing and Solgain only

Format
5¼-inch floppy disk

Language
Applesoft BASIC

Computer Needed
Apple II Plus with 48K bytes and two disk drives with an optional 80-column printer

Documentation
160 pages, in 3-ring binder (includes 11 complete examples)

Audience
Architect/engineers and owner/builders involved in design of passive solar buildings

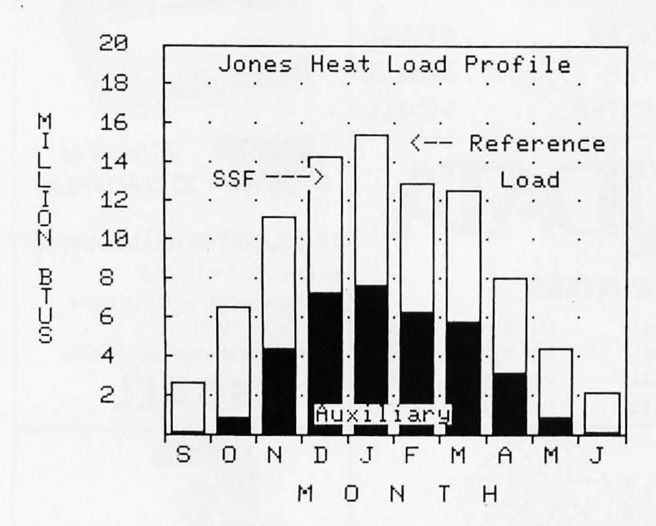


Figure 1: *Sunpas can produce a bar chart of the monthly auxiliary heating load and solar saving fraction.*

The "internal gains" menu allows the user to specify the average daily level of internal heat gains from people, lights, and appliances. These gains partially reduce the heating load. The menu also asks for the average thermostat setpoint. This is the setting, weighted hourly, of the thermostat. For instance, a 68°F day and 60°F night setting would yield an average of about 65°F. This value has a pronounced effect on the total heating load of a building and should therefore be selected with care.

Before running the analysis, the user must ensure that the disk contains monthly average climatic data for the building site. The data includes the latitude and altitude of the site, the monthly average ambient temperatures and daily swing (needed to calculate monthly average degree-days for any base temperature), and the average daily solar radiation. (This information is available for some 200 cities in the U.S. and Canada in the DOE handbook previously mentioned. The data disk of examples supplied with the software has approximately 15 cities on it.)

You run the program from the analysis set of menus. During the calculation phase, the program periodically delivers messages of its status so that the user is not left in the dark. The calculations usually take less than a minute, although the execution time may be longer if a large number of passive systems are present. The results can be printed directly and saved on disk as well.

The analysis menu lists three printing options for the computed results: the "complete print," which gives detailed information for each passive system specified; a "partial print," which repeats all important input data and all total building results (table 1); and "final results," which gives only the monthly SSF and auxiliary heating values.

I find that the "partial print" option is the best, because it repeats the input values and gives a nice breakdown of heat-loss sources and a summary of the monthly solar radiation absorbed. The final monthly results lists the net backup fuel requirement, the yearly total auxiliary use, and solar saving fraction. The complete printout gives the same information, but with the solar radiation data listed for each system.

A Sunpas graphics routine, available from the general graphics menu, produces a bar chart of the monthly auxiliary heating load, with the solar contribution highlighted. Title labeling requires user-supplied graphics text-editing software. Figure 1 shows what is possible.

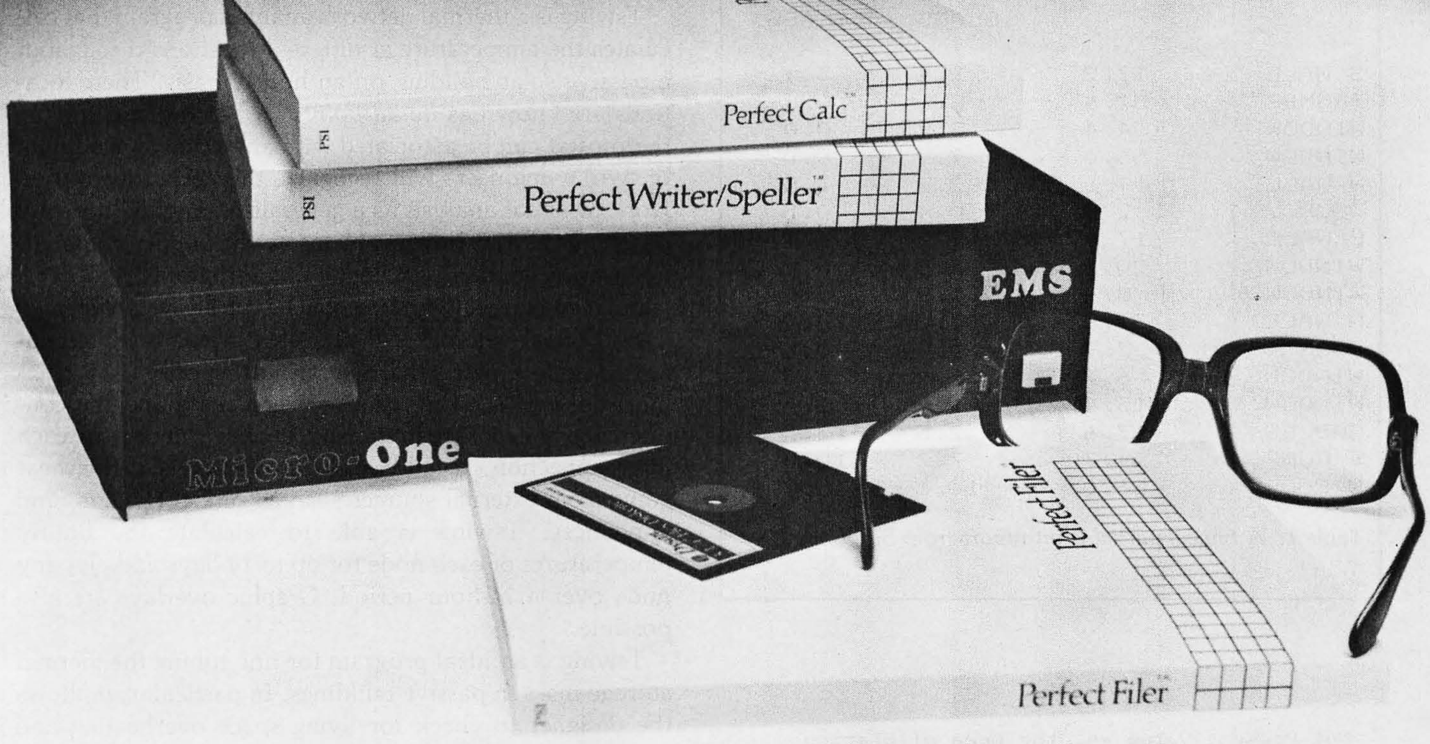
Sunop

Sunop accepts input from the Sunpas program and either calculates life-cycle costs of the passive solar system or determines the optimal mix of energy conservation and passive solar features for particular design and system cost regimes. Additionally, Sunop can graph a variety of parameters for presentation. Economic variables and analysis menus are used to set up and run the program.

The economic-variables menu allows the user to enter or edit default economic values, including financial period, down payment fraction, mortgage term, annual loan interest rate, discount rate, inflation rate, fuel inflation rate, taxes, maintenance and insurance costs, and fixed and variable system costs. The analysis follows the method found in the *Passive Solar Design Handbook* (see chapter H and appendix E of that publication for defini-

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TROMBE	57.6	8.1	0.0
WINDOW	134.4	18.9	0.0
WINDOW	56.0	7.9	0.0
W WALL	19.1	2.7	3.5
DOOR	2.9	0.4	0.5
E WALL	17.9	2.5	3.3
WINDOW	20.2	2.8	0.0
WINDOW	8.4	1.2	0.0
N WALL	21.3	3.0	3.9
DOOR	2.9	0.4	0.5
WINDOW	6.7	0.9	1.2
WINDOW	13.4	1.9	2.4
GABLES	17.6	2.5	3.2
S ROOF	54.7	7.7	10.0
N ROOF	86.0	12.1	15.7

Table 1: *A typical partial print report from Sunpas.*

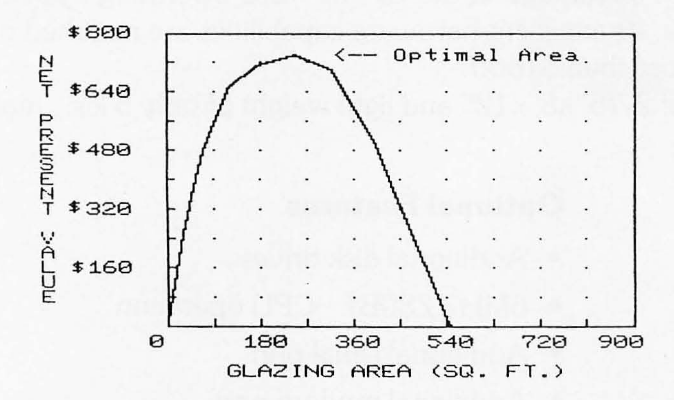


Figure 2: *Graphic output of one of Sunop's life-cycle cost runs.*

tion of terms and method of economic analysis). To perform the optimization routine, a builder's cost file must be created. In it, a user specifies different levels of insulation and their costs for each building component (wall, ceiling, etc.). From this information, Sunop can determine whether it is more cost-effective to add insulation or passive solar area.

Sunop will output results either in table or graph form. Figure 2 shows probably the most useful presentation for life-cycle results. It is a plot of the *net present value* (discounted savings at current dollars) of a particular passive solar system versus the area of the passive system. For the building in this example, Sunop shows the optimal size of a passive solar system, given the economic assumptions in this program run. Another useful option is a printed table of annual cash flows for a particular system.

Tswing

Tswing is a thermal network analysis program that calculates the temperature at different locations throughout a passive solar building on an hourly basis. These locations are known as *nodal points*. A heating and cooling thermostat can be associated with any node (a maximum of two). Engineers will recognize this technique of network or nodal analysis as a generalized method for solving transient heat flow problems by the *implicit finite difference technique*. (In fact, this program is general enough to solve many nonsolar heat transfer problems.)

A thermal network consists of a system of interconnected nodes (figure 3). The user must specify the capacitance (ability to store heat) of each node and the conductance (rate of heat transfer between nodes) of each interconnection. In addition, the user must define heat gains from external sources such as sunlight, lights, and appliances. Tswing is able to calculate the hourly temperatures of each node for up to 14 days and plot any node over a 24-hour period. Graphic overlays are also possible.

Tswing is an ideal program for fine-tuning the thermal storage mass in passive buildings. In particular, it allows the designer to check for living space overheating and potential freezing problems in unheated areas such as sunspaces.

Tswing Submenus

Tswing contains five submenus that help the user to input data and run the program. From the main menu, the user can describe the building either node by node or zone by zone. Most novices choose the zone menu because it prompts the user for specific values and then automatically creates the matrix for the analysis. The experienced user usually selects the node-by-node menu because it is quicker. The user must define, in addition to building-related data, the weather data through the weather menu. Finally, the run menu is used to set up and perform the actual hour-by-hour analysis.

The zone menu is divided into three sections. The zone section prompts for such data as number of zones, floor area, thermal capacitance, exposed-wall area, volume, and heat-transfer coefficients. The mass section prompts for the number of nonwater thermal mass units and the number of their layers and amount of surface area, as well as the heat-transfer coefficient between them and the house air. The water section asks for the number of water mass units and their diameter and height, as well as various heat-transfer details.

The node menu requires that the user enter data via the submenus of capacitances, conductances, and constant

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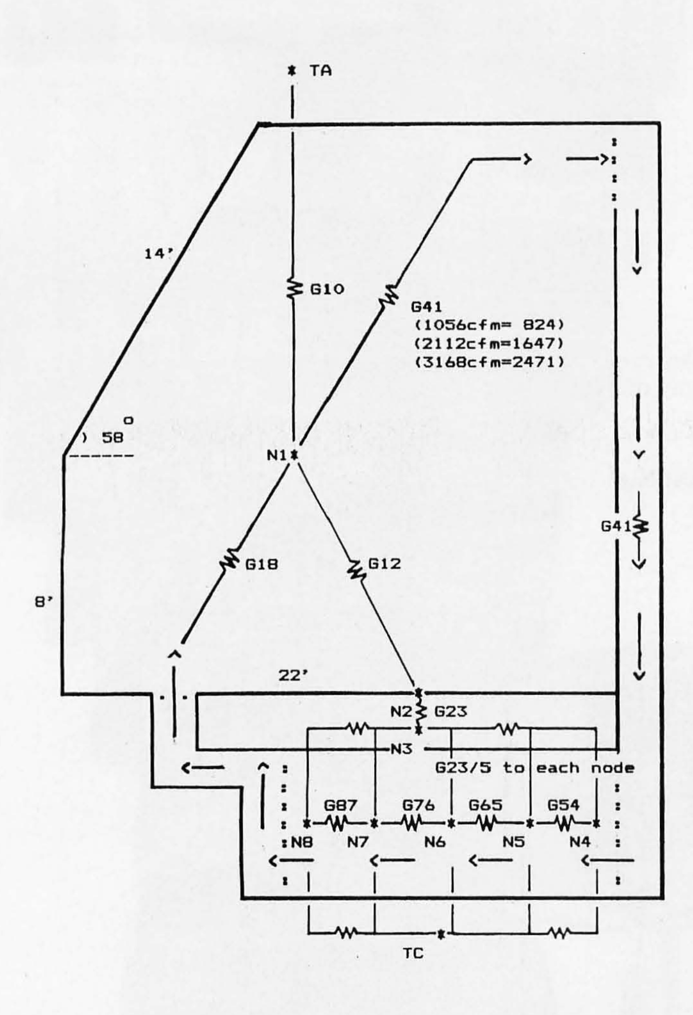


Figure 3: *Tswing describes a building as a thermal network of heat conductances and capacitances.*

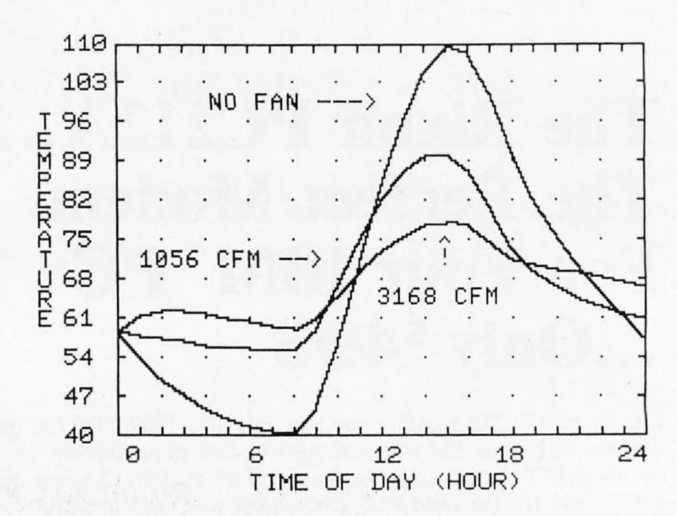


Figure 4: *Tswing enables a user to test the effect of various parameters such as airflow rate on a solar design.*

loss. Next, the user defines other important parameters that describe the operation of the building through the following submenus: movable night insulation, internal heat gains, thermostat setpoint, and solar distribution patterns.

A nice feature of Tswing is that as many as five different solar distribution patterns can be defined and then varied in the run sequences. Thus one pattern may consist of radiation for a south-facing window with an overhang, another for a south-facing window without an overhang, another for a 30-degree skylight, another for an east-facing window, etc.

The weather menu requires the user to define the ambient temperatures and solar radiation for as many as fourteen days. In the solar radiation section, the user is able to enter hourly radiation values from sunrise to sunset for each of five different surfaces. These surfaces

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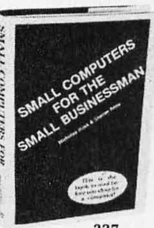
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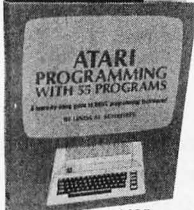
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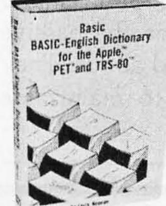
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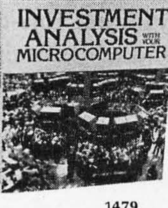
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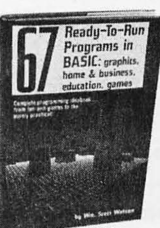
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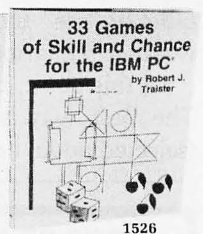
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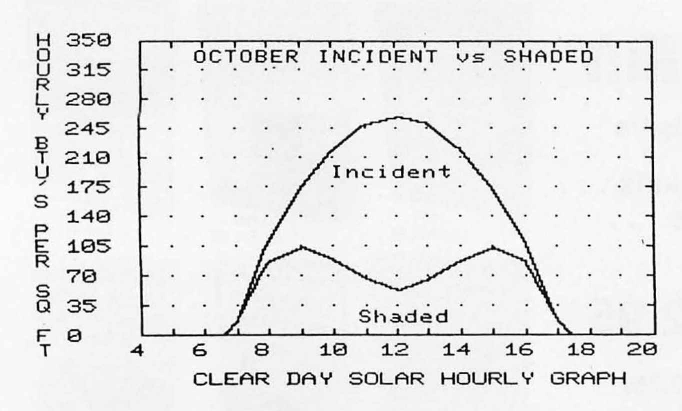


Figure 5: *Solgain computes the heat gained by a building as a result of the sun's rays passing through its windows.*

must correspond to the five different solar distribution patterns mentioned above. Actually, a user needs to enter only the total daily radiation and the number of sunlight hours. Tswing will compute the values automatically in a sine-wave pattern with the peak at noon. The hourly ambient temperatures are entered in a similar fashion. The same sine-wave auto-entry feature can be used here as well. The user needs to enter only the average temperature and the daily temperature swing.

Before the actual simulation can start, the user must first define the initial temperatures of each node (default values are 65°F), the number of days in the simulation, and the specific display format on either the screen or the printer. The selection of the number and type of days is very crucial. For instance, the user can define a clear, cold day and a cloudy, cold day, etc. Then by simply changing the order or number of days, the user can quickly "see" the building's performance in all possible weather scenarios.

At this point, the user is ready to begin the simulation. The best way to do this is to print the results first (selected nodal hourly temperatures and net backup heating and/or cooling load) and then rerun selected parts of the simulation for graphic presentation. An unfortunate limitation of the software is that only one day can be graphed. It is possible, however, to overlay different simulations (as in a parametric study) on one graph (figure 4). This is an excellent feature to have when you are presenting different options of a design to a client for review.

Solgain

Solgain calculates the clear-day solar gains on the twenty-first of each month. It calculates, from the horizontal and overhang size, incident and transmitted radiation through single- or double-glazed windows, with varying shading coefficients, orientation, and tilt. Solgain menus prompt for some 16 input parameters. These include the window's latitude, angle from the horizontal, azimuth, shading coefficient, heat-transfer factor, dimensions, and fixed and adjustable overhang details and dimensions.

Solgain displays results either graphically or in table form. A nice feature is its ability to plot hourly solar gains (figure 5). The user has the choice of selecting any two of the following solar radiation components: incident, incident (shaded), transmitted, or transmitted (shaded).

Conclusion

The Solarsoft package is a tour de force for quantifying passive solar building performance. The Sunpas, Sunop, Tswing, and Solgain programs are the state of the art in microcomputer estimation techniques. Our architectural and engineering firm regularly uses the Sunpas and Tswing programs to analyze and fine-tune the passive solar buildings we design and are consulted about. They are a quick and inexpensive alternative to mainframe simulation methods. ■

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The Ins and Outs of the TRS-80 Color Computer

Find out how the Color Computer interfaces with the outside world.

Colin J. Stearman
143 Ash St.
Hopkinton, MA 01748

My TRS-80 Color Computer was not home long before I was searching through back issues of BYTE to find out what was known about the internal workings of the unit. My interest aroused by a few excellent articles (see references 1 and 2), I was soon "peeking" and "poking" around inside my new purchase to find out more.

This article should further whet your appetite for exploration by giving you details on how the Color Computer interfaces with the outside world. I have also included some other tidbits of information to help you on your way to a better understanding of the internal workings.

The Peripheral Interface Adapter

The MC6809E microprocessor interfaces with the outside world (and some other internal devices) through a PIA (peripheral interface adapter) integrated circuit (IC), numbered MC6821 by Motorola. The MC6821 pin configuration is shown in figure 1.

The purpose of the PIA is to enable the microprocessor to receive and transmit signals and interrupts from the outside world. Because these needs vary so much with each application, the MC6821 has been designed with maximum flexibility in mind. The IC contains two independent interface circuits, which are nearly identical in operation. Each circuit can receive or transmit as many as eight digital signals in any combination (three in, five out; one in, seven out; etc.). In addition, each has two control lines, one dedicated to input and the other selectable as either input or output.

There are actually two PIAs in the Color Computer, one mainly for accepting keyboard entry (PIA1) and the other for external communication (PIA2). Each PIA is assigned four memory locations; PIA1 has hexadecimal addresses FF00 through FF03 and PIA2 has hexadecimal addresses at FF20 through FF23. In fact, only the least significant 2 bits of the address are used, along with the "chip-select" signal, making hexadecimal addresses FF04 and FF08 through FF1C for PIA1 equivalent to hexadecimal FF00. Also, only the least significant 2 bits are used with the other PIA1 and PIA2 addresses.

A block diagram of the input/output (I/O) components in the Color Computer is shown in figure 2. The PIAs receive and transmit signals to the digital-to-analog (D/A) converter, keyboard, joysticks, joystick fire buttons, cassette port, RS-232C port, video-display generator IC, analog comparator, audio-output selector, single-bit sound output (produces sound by switching one bit on and off rapidly), memory size jumpers, and interrupts used for timing purposes.

Figure 3 shows the allocation of the I/O and control lines of the two PIAs. The function of each of the identified lines is given in the following sections.

The Cassette Interface

Both the incoming and outgoing audio signals are passed through signal-conditioning circuits. Data is recorded on tape by a frequency-shift-keying (FSK) technique. This circuit can be used for many purposes not related to cassette storage. The output of the D/A converter is connected to lines PA1 through PA7 of PIA1 via

About the Author
Colin Stearman is a field engineering manager for Boston Digital Corporation.

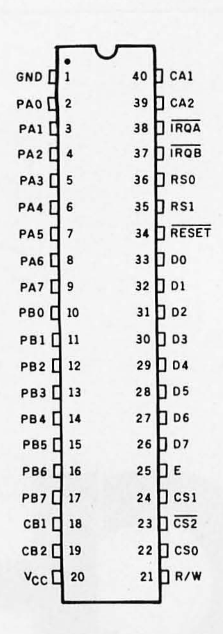


Figure 1: *The peripheral interface adapter (MC6821) provides a flexible general-purpose interface between any of the 6800 series microprocessors and the outside world.*

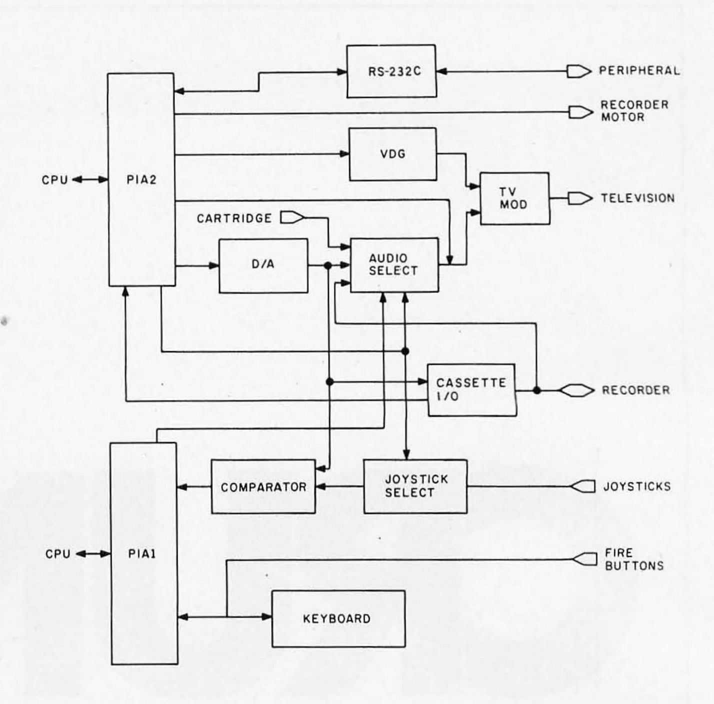


Figure 2: *The TRS-80 Color Computer input/output system. The two PIAs are efficiently used to perform all of the I/O tasks needed by the Color Computer. The PIAs pass signals that are used for functions ranging from keyboard entry to cassette-recorder control to graphic-display control.*

a scaling circuit. This results in an analog voltage at pin 5 of the cassette socket. This voltage varies from 55 millivolts (mV) to 1.126 volts (V) in 17-mV steps. Outputting numbers from 0 to 63 onto the upper 6 lines of PIA2 will set the voltage. To demonstrate this, connect a voltmeter or oscilloscope (set to direct-current coupling) to the cassette output, pin 5. Then enter and run this BASIC program:

```
10 FOR I=0 TO 63
20 POKE 65312,(PEEK(65312) AND 3) OR (I*4)
40 NEXT I
50 GOTO 10
```

Your meter or oscilloscope will show a slowly rising direct current (DC) voltage, which will suddenly fall to 0 and then start rising again. The result will be a positive-going sawtooth waveform. The slowness is due to the relative slowness of the BASIC interpreter. A machine-code routine would be much faster.

In line 20, multiplying I by 4 shifts the value of I to bits 2 through 7. Using the AND function with 3 and the current contents of the address returns the value of bits 0 and 1. Use the OR function with the result and the desired number, and put the final result back into the PIA. This is an important technique that you will see used elsewhere in this article. It allows modification of selected I/O lines without interfering with others.

Remember that this output is a voltage signal and that no power can be drawn from it. However, it can be interfaced with operational amplifiers and other analog devices to perform an unlimited number of control functions, enabling your Color Computer to control a variety of analog hardware with the right interface circuit. Possibilities include temperature control, model train

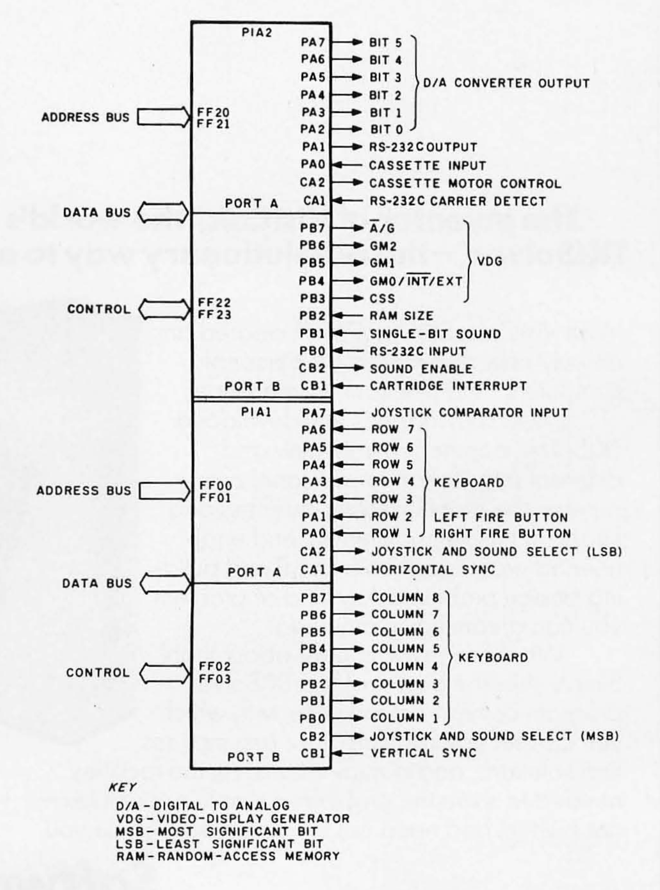


Figure 3: *The PIA pin assignments. All available connections to the two PIAs are used, in some cases for more than one purpose. The great flexibility of the MC6821 makes this efficiency possible.*

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The cassette port also contains a relay contact for starting and stopping the recorder. The contact is rated at 0.5 amperes (A) at 6 V. It is completely isolated from all other computer circuits and can therefore perform any on/off function you wish, within the current and voltage limitations just noted. Figure 3 shows the PIA connection for this relay. To close the relay use:

```
POKE 65313,PEEK(65313) OR 8
```

And to open it use:

```
POKE 65313,PEEK(65313) AND 247
```

All kinds of possibilities should spring to mind for this simple digital output, including "reaction-timing" games and on/off control of lights, motors, and other electrical devices through interfacing relays.

The RS-232C Interface

This port interfaces with the outside world in a serial fashion, as does the cassette port. However, the voltage levels are consistent with the EIA (Electronic Industries Association) Standard, which says that a 1 is any voltage from −3 to −25 V and a 0 is any voltage from +3 to +25 V. (However, RS-232C inputs to the Color Computer should not exceed plus or minus 12 V.) Figure 3 shows you where the RS-232C lines connect. Notice that Carrier Detect is on an interrupt line. The associated control register could be configured to enable this signal to cause an interrupt, if it were necessary for your program.

The Color Computer has a subset of the available signals in the RS-232C standard. They are Data Transmit, Data Receive, Carrier Detect, and Signal Ground. The Color Computer owner's manual will give you the pin locations. Transmitted signals from the Color Computer are at approximately plus or minus 10-V levels.

The functions of all signals, with the exception of Carrier Detect, are implied by their names. Carrier Detect is a signal sent to the Color Computer by the other device (modem, etc.) to say that the device is there and ready.

You can output data through the port by connecting a 9-V battery between Signal Ground and Data Receive. Put the negative side of the battery to Signal Ground. Then, type LLIST to output your program through the port output line (put your oscilloscope on the line if you have one), and the OK prompt will reappear. If the program is long, it might take a while because transmit speed is only 600 bps (bits per second, or about 60 characters per second) using LLIST.

RS-232C data is transmitted serially as one 0 start bit, seven data bits (least significant bits first), a 0 for bit 8, and two 1 stop bits. A total of 11 bits are sent for each character. The "at-rest" condition of the line is a 1.

On power up, the serial-transmission rate is set at 600

bps to be compatible with Radio Shack printers. You can change this rate by putting parameters into hexadecimal addresses 0095 and 0096. The first holds the most significant byte. Initially the value is 87 (0 in 0095, and 87 in 0096), generating 600 bps. Experiment with different numbers, and you'll find that the speed can be varied from 110 to at least 4800 bps. An 18 will give 2400 bps, and 180 results in 300 bps, for example.

Many RS-232C interfaces are commonly implemented using a universal asynchronous receiver/transmitter (UART) IC. This takes care of all timing and synchronizing. A UART has the capability of receiving and transmitting data simultaneously. But the Color Computer doesn't have a UART, so these functions must be performed by software, requiring some pretty fancy programming. However, I can demonstrate here that the Color Computer is capable of transmitting at various rates through the RS-232C port.

The program in listing 1 is in machine code and will continuously send a character you type, at the rate you select. It uses a machine-code loading technique described in the Color Computer BASIC manual. No heed is paid to the Carrier Detect or Data Receive lines for this demonstration. Repeating the character triggers your oscilloscope, allowing you to study the waveform of the data. Remember, it transmits the character in ASCII (American National Standard Code for Information Interchange).

Study the flow diagram in figures 4a and b to see how the program works. Delays are developed using loops in machine code similar to FOR. . .NEXT in BASIC. Small delays can also be created using the NOP (no operation) machine-code instruction, which causes the microprocessor to do nothing for two machine cycles, or the BRN 00 (branch never) instruction, which uses up three machine cycles.

The Color Computer runs at 0.895 MHz, making each cycle last 1.117 microseconds (μs). The machine-code routine must delay the program for 93 machine-code cycles times the bps code, between outputs of each bit. A

Listing 1: *Variable-bps-rate RS-232C transmitter. This demonstration program polls the keyboard for a depression and continually transmits the ASCII code for that character via the RS-232C port. An oscilloscope lets you study the resulting waveform.*

```
5 CLEAR 25,3950
6 DIM RATE(7)
7 FOR I=1TO7:READRATE(I):NEXT
8 DATA 64,32,16,8,4,2,1
10 A=3957
12 AA=A
17 DATA AD,9F,A0,00
19 DATA 27,0B
21 DATA 81,03
23 DATA 26,04
25 DATA 4F
27 DATA 7E,B4,F4
29 DATA A7,8C,6A
30 DATA A6,8C,67
31 DATA A7,8C,66
32 DATA 69,8C,63
33 DATA 4F
35 DATA B7,FF,20
37 DATA 26,00
39 DATA 26,00
41 DATA 26,00
43 DATA 26,00
45 DATA AD,8C,32
47 DATA 10,8E,00,08
49 DATA A6,8C,4D
51 DATA 84,02
53 DATA B7,FF,20
55 DATA AD,8C,23
57 DATA 66,8C,42
59 DATA 31,A2
61 DATA 26,EF
63 DATA 26,00
65 DATA 12
67 DATA 86,02
69 DATA B7,FF,20
71 DATA 26,00
73 DATA 8E,00,04
75 DATA 26,00
77 DATA 30,82
79 DATA 26,FA
81 DATA AD,8C,06
83 DATA AD,8C,03
89 DATA 6E,8C,A5
91 DATA 8E,00,03,12,12,30,82
93 DATA 26,FA,E6,8C,15,C0,01
95 DATA 27,0E,26,00,8E,00,06
96 DATA 12,12,30,82,26,FA,6E
97 DATA 8C,EE,39
98 DATA LAST
99 PRINT"LOADING MACHINE CODE...."
100 READ HEX$
102 IF HEX$="LAST" THEN 150
105 GOSUB 1000
110 PRINT"ADDRESS:";A,"DATA: ";HEX$;" /";BYTE
120 POKE A,BYTE
125 A=A+1
130 IF A>4095 THEN PRINT"OUT OF MEMORY":END
135 GOTO 100
150 B=INT(AA/256)
155 POKE 275,B
160 POKE 276,AA-B*256
165 PRINT"CODE ENTRY COMPLETE"
166 INPUT"<RETURN> TO CONTINUE";A$
170 CLS:PRINT"BAUD RATE SELECTION"
171 PRINT@36,"0 - STOP":PRINT@68,"1 - 150"
172 PRINT@100,"2 - 300"
173 PRINT@132,"3 - 600"
174 PRINT@164,"4 - 1200"
175 PRINT@196,"5 - 2400"
176 PRINT@228,"6 - 4800":PRINT@260,"7 - 9600"
177 PRINT@320,"SPEED";
178 INPUT BD
179 IF BD<0 OR BD>7 THEN 177
180 IF BD=0 THEN CLS:END
190 CLS
192 PRINT@230,"PRESS ANY KEY TO"
193 PRINT@262,"TRANSMIT ITS CODE"
194 PRINT@292,"<BREAK> TO SET SPEED"
200 POKE 4081,RATE(BD)
210 A=USR(0)
220 GOTO 170
1000 IF LEN(HEX$)>2 THEN PRINT"DATA ERROR":END
1005 UP=ASC(HEX$)
1010 LO=ASC(RIGHT$(HEX$,1))
1015 BYTE=0
1020 IF UP>64 AND UP<71 THEN BYTE=(UP-55)*16:GOTO1050
1025 IF UP>47 AND UP<58 THEN BYTE=(UP-48)*16:GOTO1050
1030 PRINT"DATA ERROR: ";HEX$
1040 END
1050 IF LO>64 AND LO<71 THEN BYTE=BYTE+(LO-55):RETURN
1060 IF LO>47 AND LO<58 THEN BYTE=BYTE+(LO-48):RETURN
1070 GOTO 1030
```

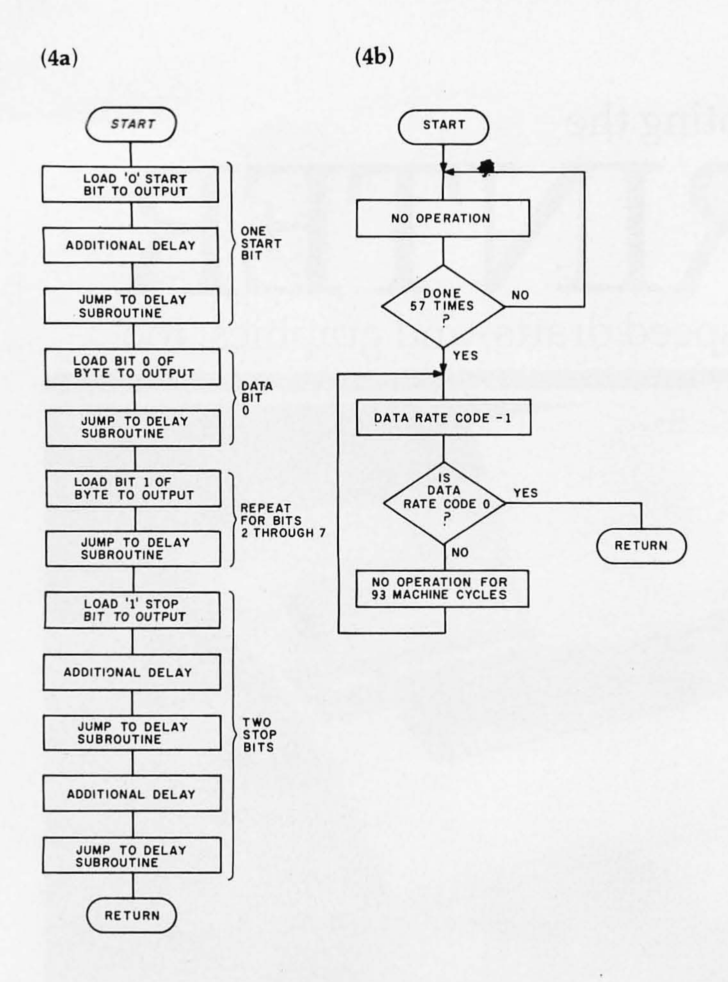


Figure 4a and b: *Variable-bps-rate flow diagram showing a variable delay subroutine (4b) used to minimize storage space consumption. The main routine (4a) could be modified to transmit one stop bit if desired.*

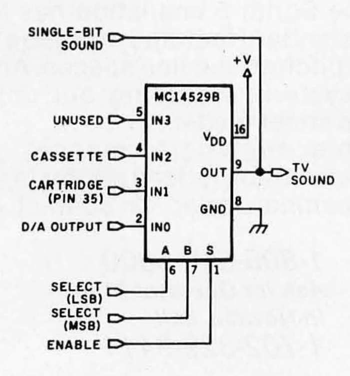


Figure 5: *Audio-signal-select multiplexer. A solid-state analog switching IC is used to route audio signals from one of three sources to the television modulator. The second half of the IC is used for selection of the joystick signals.*

subroutine is used to create this time delay, resulting in the equation:

$$\text{bps code} \times 93 \times 1.117 = \text{delay in microseconds}$$

The bps code for each desired rate is computed by:

$$\text{bps code} = \text{maximum bps/required bps}$$

In this program, the maximum bps is 9600. The variable bit rates and codes are shown in the following table. After each bit is loaded into the output port, this delay is called and the associated data-rate output results.

Data Rate	Bps Code	Required Delay	Actual Delay
150	64	6.67 ms	6.65 ms
300	32	3.33 ms	3.32 ms
600	16	1.67 ms	1.66 ms
1200	8	0.833 ms	0.831 ms
2400	4	0.417 ms	0.416 ms
4800	2	0.208 ms	0.208 ms
9600	1	0.104 ms	0.104 ms

The Audio Interface

When you use Color BASIC's sound-producing instructions, audible signals are routed through the television modulator to your television speaker. Complex sounds generated by the game cartridges may also be directed to the speaker. The switching is performed by one half of a dual four-channel analog multiplexer (Motorola MC14529B). The other half is used for the joystick inputs described later. The MC14529B selects one of four analog sources to switch to the output, based upon a 2-bit binary code. The IC can also be totally disabled by making PIA2, line CB2, equal to 0. Figure 3 shows the PIA outputs that feed to this IC. Figure 5 shows the logic circuit that accomplishes this switching.

There are only three sources of audio signals (AUDIO ON, SOUND, and a game cartridge), so the fourth line is unused. To select the audio multiplexer, PIA2, line CB2, must be a 1, and the right code must be output from PIA1, lines CA2 and CB2. The following table shows the audio-selection-code combinations and their effects.

PIA2 CB2	PIA1 CA2	PIA1 CB2	Resulting Output To Television
1	0	0	D/A converter
1	0	1	cartridge
1	1	0	cassette
1	1	1	not used

To set and clear PIA2, line CB2, use:

```
POKE 65315,(PEEK(65315) OR 8)
POKE 65315,(PEEK(65315) AND 247)
```

Listing 2: *BASIC sound-generator program. The D/A converter may be used to produce audible sounds if you switch the digital number fed to it. This program demonstrates the technique.*

```
10 POKE 65495,0
12 POKE 65315,PEEK(65315)OR8
14 POKE 65281,PEEK(65281)AND 247
16 POKE 65283,PEEK(65283)AND 247
20 POKE 65312,0
30 POKE 65312,252
40 GOTO20
```

To set and clear PIA1, line CA2, use:

POKE 65281,(PEEK(65281) OR 8)
POKE 65281,(PEEK(65281) AND 247)

To set and clear PIA1, line CB2, use:

POKE 65283,(PEEK(65283) OR 8)
POKE 65283,(PEEK(65283) AND 247)

Listing 2 shows a demonstration of the use of the D/A converter to generate a sound. This program switches the D/A converter lines from 0 to 255 and sends the resulting square wave to the television speaker. To increase the frequency of the sound (BASIC is rather slow), the microprocessor is run at the dual speed, as described in the articles in the references. (This technique may not work on your Color Computer and should never be used on disk-based systems.) Even so, the resulting sound is a low-frequency buzz and not the clean sound made by the machine-coded SOUND instruction.

Finally, it's worth mentioning the existence of a single-bit sound output. PIA2, line PB1, is normally configured as an input. However, it is connected to the same point as the audio multiplexer output, as shown in figure 5. Therefore it is possible to reconfigure the port to make PB1 an output and send bit-stream sound to the television. Imaginative programming in machine code should create some interesting sounds from this output. Care should be taken when using this feature to prevent conflicts between this output and the one from the multiplexer.

The Joystick Interface

In the section on the cassette interface, I discussed how an analog signal can be obtained from the Color Computer under program control. It may have occurred to you that it would be nice to also have the unit read in an analog signal from outside. Not only can your Color Computer do this, but it can do it for four different analog signals! This is because the joysticks develop two analog signals each, depending upon the up-down, left-right position of the stick. But the range of the analog input signal is 0 to +5 V, so care should be taken not to exceed either of these limits.

If analog signals are to be read in by the Color Computer, they can be connected to the joystick pins and read by the JOYSTK instruction. Don't forget, though, that you must execute a JOYSTK(0) before reading any other joystick input (see the Color Computer BASIC manual).

The joystick selection is made by PIA1, lines CA2 and CB2, as shown in the following table of joystick input selection codes.

PIA2		Resulting
CA2	**CB2**	**Input From**
0	0	right joystick (side-to-side motion)
0	1	right joystick (up-and-down motion)
1	0	left joystick (side-to-side motion)
1	1	left joystick (up-and-down motion)

With the information in the preceding table, you should be able to write a BASIC routine to perform the successive-approximation A/D conversion and read the analog value at any one of the analog ports. The possibilities for this capability are endless. Some that quickly come to mind include using your Color Computer to monitor indoor/outdoor temperature, monitor and analyze weather variables, and digitize and display analog waveforms like an oscilloscope wave.

Just as the cassette output provided a digital output signal via the motor control relay, the two joystick inputs can be used to enter digital inputs to the Color Computer. The "fire" push buttons on each joystick change the contents of address FF00 from 255 (or 127) to 254 (or 126), as described in the Color BASIC manual. The alternates to each number are due to the comparator being input into PA7 (the most significant bit) of this address; this bit could be a 1 or a 0.

The push buttons ground the input lines when pressed and are therefore digital inputs. Any digital input that goes from short to open (such as a relay contact) can be connected to these inputs and read by a program in the same way as described for the push buttons. Because there are two inputs of this type, the Color Computer could be made to read any 2-bit digital input, thus giving you four possible combinations.

Conclusion

From this article you should have some insight into how the Color Computer connects to the outside world. The microprocessor in the Color Computer is a powerful device, capable of performing many interesting and useful tasks. A better understanding of the I/O structure is essential if you want to take full advantage of these capabilities. ■

References

1. Ahrens, Tim, Jack Browne, and Hunter Scales. "What's Inside Radio Shack's Color Computer?" March 1981 BYTE, page 90-130.
2. Baker, Woody. "A Closer Look at the TRS-80 Color Computer." October 1981 BYTE, page 334-340.

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A Conceptual Approach to Real-Time Programming

You can use various real-time programming techniques to turn a lazy computer into a real worker

Craig R. Wyss
Department of Physiology, SJ-40
University of Washington
Seattle, WA 98195

If you have worked with a word processor or played a game of Asteroids, then you have used a real-time program. And if you have ever wanted to collect data in your home or laboratory or control something using a computer, then you've needed a real-time program.

Indeed, any situation in which events happening in the logical world of the computer must interact in a timely fashion with events happening in the outside world requires real-time programming. Furthermore, using efficient real-time programming techniques even when a particular job does not absolutely require them is always good practice. A program that spends equal time on computation and output can run almost twice as fast if it's based on a real-time approach. A well-crafted real-time program can be written in a high-level language, do its job, and still be loafing while a poorly designed assembly-language program doing the same job barely keeps up. Finally, skills developed in writing real-time applications programs can be transferred directly to systems programming—all multi-user operating systems are real-time programs.

This article presents a conceptual approach for defining real-time problems and specific programming techniques for solving them. All real-time programming jobs involve three or more of the following subjob types:

- Data collection—This subjob class includes reading the keyboard, reading analog and digital inputs, etc. All real-time programs collect at least some data, and usually this task is their first priority.
- Data analysis—Analysis may be as simple as monitoring the input data for special values or as complex as performing Fourier transforms on blocks of data. As a general rule, the time required for data analysis depends on the input data: for example, in a word processor the time required to deal with an input character calling for a block move is much greater than the time necessary for data analysis on most characters.
- Data display—Display includes not only output to a video display or printer but also any outputs—digital or analog—used to control events in the real world. Outputting results may be a high-priority job (if, for example, the computer is in a control loop) or a low-priority job (as in word processing, where keeping up with the keyboard is much more important than displaying characters).
- Data storage—Writing results to a mass-storage device is logically equivalent to displaying data, but it is practically different in that data typically has to be transferred in blocks. Thus, data storage is an ultra-high-priority task during the actual transfer but is at the bottom of the pecking order most of the time.

Batch-Programming Approach

The normal or batch-programming approach to these four subjobs is to do them serially, i.e., wait for input, analyze it, and provide an output. The problem with this approach is twofold. First, peripherals are much slower than microprocessors so that a vast amount of time is wasted waiting for input or output devices to set their READY flags. Second, a batch program that may have plenty of time to analyze data, output results, and get back to the top of its loop when deal-

About the Author

Craig Wyss is a cardiovascular physiologist. He began writing real-time programs in 1969 using a Digital Equipment Corporation PDP-8.

ing with most inputs can have real trouble when it encounters input data requiring more extensive analysis. The efforts of the real-time programmer are directed at figuring out how to do useful work when the typical batch program is inactive while waiting for peripherals or performing only simple data analysis.

The basic ingredients necessary for writing efficient real-time programs are two powerful programming tools: *buffering* and *coprocessing*. To illustrate these techniques I will show how *any* real-time task could be accomplished efficiently in an ideal hardware environment. The secret of success is to allow each of the subjobs to execute independently, and the easiest way to do that is to assign one processor to each subjob, as indicated here:

- Processor #1 collects data as it becomes available from an input device and stores it in a first-in/first-out (FIFO) buffer. A FIFO buffer can be thought of as a pipeline: one device puts data into one end of the pipe, while another takes data out of the other end.
- Processor #2 gets data, as the data is needed or as it becomes available, from the FIFO, which is fed by processor #1. Processor #2 then analyzes the data and passes results to FIFO buffers for display and storage.
- Processor #3 displays the data placed in its buffer by processor #2.
- Processor #4 transfers into a local buffer data from the buffer that is fed by processor #2. When its local buffer is full, processor #4 writes the buffer contents to the storage device and then returns to collect any data that processor #2 provided while processor #4 was busy. An alternate and more efficient approach involves having two or more local buffers for processor #4, which can tell processor #2 which buffer is available for receiving data.

This scheme is worth studying in some detail because it is more subtle than it appears. Note that everything works asynchronously. Processors are doing their job, waiting for a peripheral or waiting for data to appear in their input buffers. Processors may be temporarily ahead of or behind each other (as, for example, when processor #4 needs to write to the storage device or when processor #2 is performing an especially long analysis), but the FIFO buffers take up any slack. The only constraints are that the FIFO buffers must be big enough to absorb all the data generated by a source processor while the receiving processor is doing whatever jobs keep it from servicing its input buffer and that *on the average* each receiving processor must be fast enough to process its input data; time lost on long jobs must be made up later. Thus, if we all had multiprocessor computers, real-time problems could be solved simply by parceling out jobs and providing interprocessor-communication buffers. Unfortunately, most computer systems have only one processor; the rest of this article describes techniques for making one processor act like many.

To map the general real-time algorithm onto only one processor, you can set up a number of logically independent subprograms that pass control of the processor back and forth under either software or hardware control. These subprograms may be either subroutines or coroutines in actual structure, but it is best to think of them as coroutines in order to keep close to the multiprocessor model. Many programmers are unfamiliar with the concept of a coroutine, but it is basically simple. Coroutines differ from subroutines both conceptually and structurally: Conceptually, coroutines can be thought of as equal partners in performing a job rather than as master and slave. Structurally, coroutines differ from subroutines in that control of the microprocessor may be relinquished at any point in the coroutine and then resumed at that point when other coroutines return control; in contrast, subroutines are initiated at their beginning every time they are called. To logically model multiple processors, you set up multiple coroutines that relinquish control of the microprocessor when they are waiting for a peripheral, waiting for data to appear in their input buffer, or performing a low-priority task. The exact programming techniques to use depend on whether input/output (I/O) is programmed, interrupt driven, or under direct-memory-access (DMA) control.

Programmed I/O

When I/O is programmed, the microprocessor directly monitors the state of peripherals by reading *status* registers and doing conditional branches as appropriate. The big advantage of this approach is that programs can be written in a virtually hardware independent manner; for example, all commercially available programs designed to run under CP/M use programmed I/O. Some very sophisticated real-time programs have been written this way; Wordstar, a word processor, can concurrently print a file, monitor the keyboard, and update the screen display in real time. Unfortunately, the disadvantages of using programmed I/O for real-time programs are enormous. The major problem is that implementation of any useful real-time algorithm requires tricky and hard-to-modify programming because the program must always check flags fast enough to catch desired inputs; these checks must be done at frequent intervals, *no matter what path the program takes.*

As an example of a solution to a real-time problem in a programmed I/O environment, listing 1 (see page 464) outlines a program that periodically reads analog data, analyzes it, and outputs results to a printer. Written in Pascal, the program uses three coroutines (the main routine, CHECK_A_TO_D, and ANALYZE_DATA) and two subroutines (OUTPUT_RESULTS and CHECK_KEYBOARD), all operating asynchronously and passing data to each other via FIFO buffers. In looking at the listing, note how awkwardly the coroutines are imple-

mented necessarily (using CASE statements) and how the programmer must anticipate the execution time required for each program segment. Hardware interrupts can eliminate these problems.

Interrupt-Driven I/O

Almost all micro- and minicomputers support hardware interrupts. An interrupt is a subroutine CALL initiated at the request of a peripheral device; modern computers have vector-interrupt schemes that allow each interrupting peripheral device to initiate a CALL to its own service routine. Most bus standards specify a priority-interrupt arrangement whereby a high-priority device may interrupt the service routine of a lower-priority device. The main program usually does the lowest-priority tasks (i.e., any device may interrupt it), but the interrupts may be disabled (locked out) when it has a high-priority job to do or when intertask communication buffers are being updated.

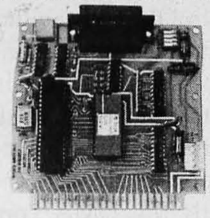
The advantages of using interrupt-driven I/O for real-time jobs are substantial: first, the technique greatly reduces time lags in servicing input devices; this feature is especially important when you are sampling analog data at supposedly regular intervals. Second, programs run faster because they require *little overhead* for switching between coroutines or reading status registers. Third, devices requiring frequent servicing may be accommodated *while the* microprocessor is still doing useful data analysis. And last, clean real-time programs practically fall out of an interrupt-driven I/O environment; the main routine (usually doing the job of processor #2, data analysis) and the interrupt service routines can be thought of as coroutines doing one of the four types of subjobs in the general algorithm. The disadvantage of interrupt-driven programs is that they are hardware dependent, an insuperable problem for commercial CP/M programs unless a hardware package is provided with the software. Listing 2 (page 467) shows the same real-time problem treated in listing 1, but in listing 2, it is solved using interrupt-driven I/O. I have tried to illustrate most of the tricks you will need and pitfalls you will encounter in setting up an interrupt-driven program; in particular, remember that you rarely know when any peripheral is going to request service.

In my discussion so far I have avoided one of the biggest real-time programming headaches—writing to mass-storage devices. I mentioned earlier the schizophrenic nature of the data-storage function: a low-priority job most of the time, it's absolutely uninterruptible during the actual data transfer (an 8-inch double-density floppy disk must get a new byte every 16 microseconds when writing a sector). And most storage-device-handling routines do not even allow interrupts during noncritical operations (e.g., when a disk is seeking a new track), thus further compounding the problem. There are, however, several solutions.

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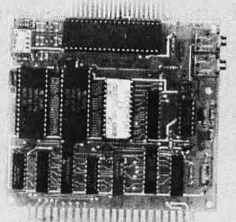
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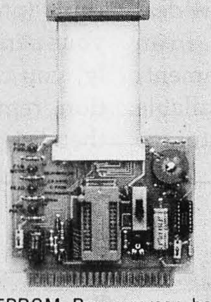
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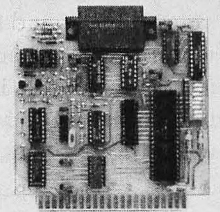
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The only solution available in a programmed I/O environment is just to work around the problem: output a Control-G to beep the console and write "stop typing" to the console before beginning any disk I/O; save the time when you start the write (if you have a clock), read the time when you get back, and then somehow deal with the gap in your input data. In an interrupt-driven I/O environment, two other solutions are available when floppy disks are the storage media: the first involves getting into your disk driver and moving the disable-interrupt instruction (DI) so that it executes just before the actual write command (after completion of all that time-consuming seeking); in this case, only 167 milliseconds (ms), at most, will be unavailable for interrupts (one revolution of the disk). If your peripherals interrupt infrequently, you can employ an alternate solution: remove all DI instructions from the disk driver. Occasionally a peripheral will interrupt when an actual data transfer is in progress, but such an interrupt generates only a soft error (a lost-data error condition set in the disk-controller status register) for most disk drivers. Data transfer should succeed on one of the error retries. I am somewhat ashamed to even suggest these stopgap measures, since the only proper solution is to buy, borrow, steal, or manufacture direct-memory-access hardware for your mass-storage devices (hereafter assumed to be floppy disks).

Direct-Memory-Access I/O

A peripheral with DMA capability can be set up to act exactly like an independent coprocessor for the all-important fast-data-transfer task. It works like this: before sending a write command to the disk controller, the microprocessor tells the DMA controller where its buffer is located and how many bytes it needs to transfer. Then the write command is initiated, and the microprocessor goes on about its business. When the disk controller has found the proper sector it sets a flag indicating that it's ready for data. The DMA controller responds to the flag by requesting control of the bus from the microprocessor. At the end of its current memory cycle, the microprocessor relinquishes control of the bus and acknowledges the bus request. Upon receiving bus acknowledgment, the DMA controller reads a data byte from its buffer and transfers the data byte to the disk controller. The DMA controller then returns the bus to the microprocessor and increments its buffer address and byte count. If the byte count is exhausted, the DMA controller sets status flags and generates an interrupt if it has been so programmed (usually the disk controller is allowed to do the interrupt for end of transfer because the write command might abort on an error before transfer is complete). The whole process takes only a few microseconds for each byte; the microprocessor is hardly slowed down at all, and an interrupt can safely occur *any* time during the transfer.

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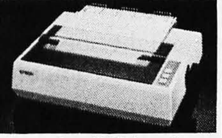
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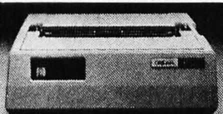
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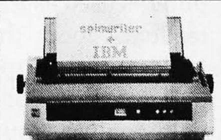
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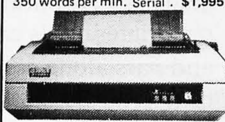
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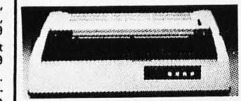
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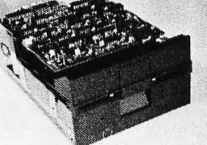
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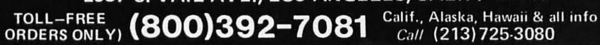


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for the S-100 bus and are definitely worth the extra $100 if you ever plan to write a real-time program. Most manufacturers supply software, but to get to know a machine inside out, you should try writing an interrupt and DMA-driven disk I/O routine. Furthermore, standard software routines *wait* while the write takes place to prevent the calling program from corrupting the buffer area before the transfer is done. If the manufacturer supplies a listing of its software, a little creative tinkering can defeat the wait and enable one of the coroutines in the calling program to monitor the transfer to see when the buffer is free for more data; alternatively, you could alter the end-of-transfer interrupt service routine to perform whatever services your data storage subjob needs then. Poor or enthusiastic hardware hobbyists might want to experiment with the powerful DMA controller chips available for most microprocessors.

Final Words and Warnings

There are some tricky spots where you should watch your step. Because the key to good real-time programming is buffering and asynchronous processing, some strange time relationships can develop between events in the real world and events in the logical worlds of the coroutines. In fact, the term *real-time* is misleading because all programs work on data that was collected at some prior real-world time. Consider, for example, a 500-byte input buffer filled at a one-byte-per-second rate by an analog/digital-converter service routine; if the data analysis routine got temporarily behind for some reason (e.g., it needed to do a *lengthy* calculation), real-time for the data-analysis routine might be several minutes behind real-time from the point of view of a keyboard service routine. Normally, these time shifts are advantageous because they allow more useful work to be wrung out of the computer while still catching all input data. But they can cause problems in some situations. For example, if the computer is used as a smart controller in a feedback loop, then both data input and control output must have high priority; time-consuming tasks in the data-analysis routine should not interfere with delivery of timely control data to the output routine (two data-analysis coroutines might be appropriate in this case: one to compute and pass along control data and a second to do other lower-priority analysis).

While data buffering occasionally can have some confusing side effects, it also comes with a bonus. After a program has been running awhile, the input buffer contains a log of the input data. Thus, any data-analysis routine can detect an event and then look back to see what led up to it. (This ability is the primary selling point for digital oscilloscopes and logic analyzers, devices that are just real-time-programmed digital processors.)

If you follow the general rules outlined here, you will find real-time programming to be a creative and rewarding activity. ■

Listing 1: *Furnishing an example of a solution to a real-time problem in a programmed-I/O environment, this program periodically reads analog data, analyzes it, and outputs results to a printer.*

```
PROGRAM MEASURE_ANALOG_PULSE;
(*   This listing illustrates a solution to a real-time task using
programmed input-output; the program is not complete since hardware
or implementation dependent procedures are shown as stubs only.
     The task that this program executes is as follows:
        1) An A-D converter is read every time a clock flag is
        set by a programmable clock.  The A-D converter is
        assumed to return values from 0 to 4095 (i.e. a 12 bit
        converter).
        2) If the analog value is greater than some threshold
        (initially set to 2000) then the program keeps track of
        how many sample periods it remains supra-threshold and
        keeps a running sum of the values.
        3) When the analog value then drops below the threshold
        value, the duration of the supra-threshold pulse and the
        average analog value during the pulse are printed to a listing
        device.
        4) The threshold may be changed at any time by hitting one of
        the keys '0' through '9' to set the threshold from 400 to
        4000 in increments of 400 (e.g. '5' sets the threshold to
        2400).  Whenever the threshold is changed the new value is
        printed on the listing device.  Hitting any key other than
        '0' to '9' terminates execution.
At no time should keyboard input be missed, and all analog values should
be read within a few  ms  of each clock pulse.  These conditions should
continue to be met even during periods when analog pulses occur frequently.
    The program is largely self-documenting.  *)

(*   Three FIFO buffers are used: one for the A-D values, one for keyboard
input, and one for lister output.  The first part of the definitions is
related to implementing these buffers. *)
CONST
        A_D_BUF_LENGTH = 100;
        KEY_BUF_LENGTH = 20;
        OUT_BUF_LENGTH = 200;
        LONGEST_BUFFER = 200;
TYPE
    BUFFER_HEADER = RECORD
        INPUT_POINTER,
        OUTPUT_POINTER,
        BUFFER_LENGTH : INTEGER;
        BUFFER_FULL,
        BUFFER_EMPTY : BOOLEAN
        END;
(*   The Buffer Header keeps the current status of a FIFO buffer.  The
input pointer points to the next location to be filled, and the output
pointer is the next location to be read from the buffer. *)
    FIFO_BUFFER = ARRAY[1..LONGEST_BUFFER] OF INTEGER;
    STRING20 = ARRAY[1..20] OF CHAR;
VAR
    A_D_HEADER,
    KEY_HEADER,
    OUT_HEADER : BUFFER_HEADER;
    A_D_BUFFER ,
    KEY_BUFFER ,
    OUT_BUFFER : FIFO_BUFFER; (* In this example all buffers occupy the
    same amount of storage space even though their lengths are different.
    I had to do it this way here because of the strong type checking of
    standard Pascal; there are a number of ways around this problem in
    most implementations (e.g. use the NEW function to allocate space
    at run time and rewrite the buffer handling procedures to use accesses
    with true pointer type variables).  *)
(*   End of buffer definitions
& start of Globals needed by other procedures.  *)
    LIST_FILE : TEXT; (* File var for the listing device *)
    A_D_SEGMENT,
    ANALYZE_SEGMENT : INTEGER; (* Used to control flow of the Coroutines *)
    ERROR, DONE : BOOLEAN; (* Booleans to control program termination *)
(* The following variables are used in the data analysis *)
    THRESHOLD, PULSE_COUNT : INTEGER;
    PULSE_SUM, AVERAGE_PULSE_HEIGHT : REAL;
    LAST_VALUE_WAS_OVER_THESHOLD : BOOLEAN;

(* The following three procedures implement the FIFO buffers *)

PROCEDURE INIT_BUFFER(VAR B_HEADER : BUFFER_HEADER; B_LENGTH : INTEGER);
BEGIN
    WITH B_HEADER DO BEGIN
        INPUT_POINTER:=1; (* Next location to be filled *)
        OUTPUT_POINTER:=1; (* Next location to be read *)
        BUFFER_LENGTH:= B_LENGTH;
        BUFFER_FULL:= FALSE;
        BUFFER_EMPTY:= TRUE
    END
END;

PROCEDURE STORE(VAR B_HEADER : BUFFER_HEADER;
                VAR BUFFER : FIFO_BUFFER;
                VALUE : INTEGER);
BEGIN
    WITH B_HEADER DO IF NOT BUFFER_FULL THEN BEGIN
        BUFFER[INPUT_POINTER]:= VALUE;
        IF INPUT_POINTER = BUFFER_LENGTH
            THEN INPUT_POINTER:= 1
            ELSE INPUT_POINTER:= INPUT_POINTER+1;
        BUFFER_FULL:= INPUT_POINTER = OUTPUT_POINTER;
        BUFFER_EMPTY:= FALSE
    END
END;
FUNCTION RETRIEVE(VAR B_HEADER : BUFFER_HEADER;
                  VAR BUFFER : FIFO_BUFFER) : INTEGER;
BEGIN
    WITH B_HEADER DO IF NOT BUFFER_EMPTY THEN BEGIN
        RETRIEVE:= BUFFER[OUTPUT_POINTER];
        IF OUTPUT_POINTER = BUFFER_LENGTH
            THEN OUTPUT_POINTER:= 1
            ELSE OUTPUT_POINTER:= OUTPUT_POINTER+1;
        BUFFER_EMPTY:= OUTPUT_POINTER = INPUT_POINTER;
        BUFFER_FULL:= FALSE
    END
END;

(* The following procedures are all implementaion dependent and are
shown as stubs with a description of what they have to do. *)

PROCEDURE INIT_LIST_FILE;
BEGIN
```

Listing 1 continued:

```
    (* This procedure should initialize the file variable, LIST_FILE,
    to the listing device; e.g. ASSIGN(LIST_FILE,'LST:'); etc... *)
END;

PROCEDURE START_CLOCK;
BEGIN
    (* Set up the clock to set a flag whenever the A-D needs to be read,
    and start the clock *)
END;

FUNCTION CLOCK_FLAG_SET : BOOLEAN;
BEGIN
    (* Returns TRUE if clock flag is set, FALSE otherwise. *)
END;

PROCEDURE START_A_TO_D;
BEGIN
    (* Initiate an analog to digital conversion. *)
END;

FUNCTION READ_A_TO_D : INTEGER;
BEGIN
    (* Reads the A-D and returns a value from 0 to 4095 *)
END;

FUNCTION KEY_HIT : BOOLEAN;
BEGIN
    (* Returns TRUE if RxRDY flag is set from the keyboard UART *)
END;

FUNCTION LST_DEVICE_READY : BOOLEAN;
BEGIN
    (* Returns TRUE if the list device is ready for a character *)
END;

PROCEDURE WRITE_STRING_TO_OUT_BUFFER(VAR STRING : STRING20);
(* This procedure puts the characters into the output buffer until
it encouters a "$". *)
VAR     I : INTEGER;
        C : CHAR;
BEGIN
    I:=1;
    REPEAT
        C:= STRING[I];
        I:= I+1;
        IF C <> '$' THEN BEGIN
            ERROR:= ERROR OR OUT_HEADER.BUFFER_FULL;
            STORE(OUT_HEADER,OUT_BUFFER,ORD(C))
        END
    UNTIL (I=21) OR (C='$') OR ERROR
END;

PROCEDURE WRITE_CRLF_TO_OUT_BUFFER;
VAR     LOCAL_STRING : STRING20;
BEGIN
    LOCAL_STRING[1]:= CHR(13); (* Carriage return *)
    LOCAL_STRING[2]:= CHR(10); (* Line feed *)
    LOCAL_STRING[3]:= '$'; (* String terminator *)
    WRITE_STRING_TO_OUT_BUFFER(LOCAL_STRING)
END;

PROCEDURE WRITE_INTEGER_TO_OUT_BUFFER(VALUE : INTEGER);
VAR     LOCAL_STRING : STRING20;
BEGIN
    (* You need to work out some way here to write the character
    string conversion of a binary integer VALUE to the variable
    LOCAL_STRING.  Most Pascal compilers allow some way of doing
    "redirected I-O" so you don't have to write the integer conversion
    routines yourself.
       In this routine, the integer character string, followed by a space,
    and a "$" should be written to LOCAL_STRING. Then:  *)
    WRITE_STRING_TO_OUT_BUFFER(LOCAL_STRING)
END;

(* The following procedure sets everything up and is only called once *)

PROCEDURE INITIALIZE_PROGRAM;
BEGIN
    INIT_BUFFER(A_D_HEADER,A_D_BUF_LENGTH);
    INIT_BUFFER(KEY_HEADER,KEY_BUF_LENGTH);
    INIT_BUFFER(OUT_HEADER,OUT_BUF_LENGTH);
(* Initialize variables *)
    A_D_SEGMENT:= 1;
    ANALYZE_SEGMENT:= 1;
    INIT_LIST_FILE;
    DONE:= FALSE;
    ERROR:= FALSE;
    LAST_VALUE_WAS_OVER_THRESHOLD:= FALSE;
    THRESHOLD:= 2000;
    PULSE_SUM:= 0.0;
    PULSE_COUNT:= 0;
    WRITE('Hit RETURN when ready to start'); (* File var OUTPUT is assumed
to be the console screen *)
    READLN; (* File var INPUT is assumed to be the keyboard *)
    START_CLOCK
END;

(* The following procedure is the first coroutine. It monitors the clock,
reads the A-D when necessary, and puts the value in the A_D buffer.
This procedure performs the highest priority task and is called as often
as possible.  The coroutine function is implemented using the CASE
statement and the variable A_D_SEGMENT to control the flow. *)

PROCEDURE CHECK_A_TO_D;
VAR     VALUE : INTEGER;
BEGIN
    CASE A_D_SEGMENT OF
    1 : IF CLOCK_FLAG_SET THEN BEGIN
            START_A_TO_D; (* but we don't need to wait for conversion *)
            A_D_SEGMENT:= 2 (* set up for next section of coroutine *)
        END;
    2 : BEGIN
            VALUE:= READ_A_TO_D; (* plenty of time for conversion by now *)
            ERROR:= ERROR OR A_D_HEADER.BUFFER_FULL;
            STORE(A_D_HEADER,A_D_BUFFER,VALUE);
            A_D_SEGMENT:= 1 (* set up for 1st section of coroutine again *)
        END
    END (* of CASE statement *)
END;

(* The following procedures are subroutines to check and read the keyboard
and to output results.  Both routines just check peripheral status flags
and do the data transfer as necessary.  This is a simple, one-step task
so they are implemented as subroutines rather than coroutines. *)
```

Listing 1 continued on page 466

Listing 1 continued:

```
PROCEDURE READ_KEYBOARD;
VAR     C : CHAR;
BEGIN
    IF KEY_HIT THEN BEGIN
        READ(C);
        ERROR:= ERROR OR KEY_HEADER.BUFFER_FULL;
        STORE(KEY_HEADER,KEY_BUFFER,ORD(C))
    END
END;

PROCEDURE OUTPUT_RESULTS;
BEGIN
    IF NOT OUT_HEADER.BUFFER_EMPTY AND LST_DEVICE_READY THEN
        WRITE(LIST_FILE,CHR(RETRIEVE(OUT_HEADER,OUT_BUFFER)))
END;

(* The following procedure is the coroutine that does all of the data
analysis.  The coroutine structure is implemented with the case statement.
Note how the data analysis function has been broken up so that this
procedure does not hog the CPU while doing complex data analysis.  The
coroutine relinquishes control whenever its buffers are empty and at
short intervals during data analysis; the whole idea is to make sure
the clock gets serviced at frequent intervals so that analog data is
sampled at close to the proper time.  Note also that the amount of data
analysis necessary is highly dependent on the input data; e.g., a whole
bunch of stuff needs to be done when the analog value falls below the
threshold value. *)

PROCEDURE ANALYZE_DATA;
VAR     C : CHAR;
        END_PULSE,
        SUPRA_THRESHOLD : BOOLEAN;
        A_D_VALUE : INTEGER;
BEGIN
    CASE ANALYZE_SEGMENT OF
    (* Case 1 checks our input buffers to see if we have any data to
    deal with.  Some minimal analysis is done in case 1 if we have data. *)
    1 : IF NOT KEY_HEADER.BUFFER_EMPTY THEN BEGIN
            C:=CHR(RETRIEVE(KEY_HEADER,KEY_BUFFER));
            DONE:= NOT (C IN ['0'..'9']);
            IF NOT DONE THEN
                THRESHOLD:= (ORD(C)-ORD('0')+1)*400;
            ANALYZE_SEGMENT:= 5 (* We relinquish control here because
        we've already spent a long time figuring out the new threshold.
        The coroutine transfers to case 5 where the new threshold is
        printed out (via the output buffer, of course).  *)
        END
ELSE (* if no data in keyboard buffer, we check A-D buffer. *)
    IF NOT A_D_HEADER.BUFFER_EMPTY THEN BEGIN
        A_D_VALUE:= RETRIEVE(A_D_HEADER,A_D_BUFFER);
        SUPRA_THRESHOLD:= A_D_VALUE >= THRESHOLD;
        END_PULSE:= LAST_VALUE_WAS_OVER_THRESHOLD
                    AND NOT SUPRA_THRESHOLD;
        LAST_VALUE_WAS_OVER_THRESHOLD:= SUPRA_THRESHOLD;
        IF END_PULSE THEN ANALYZE_SEGMENT:= 2
        ELSE IF SUPRA_THRESHOLD THEN BEGIN
            PULSE_COUNT:= PULSE_COUNT+1;
            PULSE_SUM:= PULSE_SUM + A_D_VALUE
        END
    END;
    (*  Cases 2 through 4 are the segments of the coroutine that analyze
    the data at the end of a pulse and output results.  Case 2 does
    a time consuming floating point division and then relinquishes
    control; analysis is taken up again at case 3 which outputs the
    pulse length; integer to string conversion is time consuming so
    case 3 reliquishes control and analysis continues later at case 4
    where the average pulse height (computed in case 2) is output.
    Control then returns to case one to catch up on any keyboard activity
    and accumulated analog values.  *)
    2 : BEGIN
            AVERAGE_PULSE_HEIGHT:= PULSE_SUM/PULSE_COUNT;
            ANALYZE_SEGMENT:= 3
        END;
    3 : BEGIN
            WRITE_INTEGER_TO_OUT_BUFFER(PULSE_COUNT);
            ANALYZE_SEGMENT:= 4
        END;
    4 : BEGIN
            WRITE_INTEGER_TO_OUT_BUFFER(ROUND(AVERAGE_PULSE_HEIGHT));
            WRITE_CRLF_TO_OUT_BUFFER;
            PULSE_COUNT:= 0;
            PULSE_SUM:= 0.0;
            ANALYZE_SEGMENT:= 1
        END;
    (*  Case 5 is a continuation of the analysis that occurs when a new
    threshold is specified from the keyboard.  It outputs the new
    threshold value (already computed in case 1).  *)
    5 : BEGIN
            WRITE_STRING_TO_OUT_BUFFER('New Threshold= $    ');
            (* Note that the string had to be filled out to 20 chars
            to satisfy Pascal's type checking *)
            WRITE_INTEGER_TO_OUT_BUFFER(THRESHOLD);
            WRITE_CRLF_TO_OUT_BUFFER;
            ANALYZE_SEGMENT:= 1
        END
    END (* of case statement *)
END;

(*  The following is the main program of MEASURE_ANALOG_PULSE.  It should
properly be thought of as a coroutine whose function is to pass control
around to the other coroutines and subroutines on a priority weighted
basis.  Note that the high priority routine, CHECK_A_TO_D, is given
control as often as possible.  *)

BEGIN
    INITIALIZE_PROGRAM;
    REPEAT
        CHECK_A_TO_D;
        ANALYZE_DATA;
        CHECK_A_TO_D;
        OUTPUT_RESULTS;
        CHECK_A_TO_D;
        READ_KEYBOARD
    UNTIL DONE OR ERROR;
IF ERROR THEN WRITELN('Buffer overflow abort.')
END.

(*  The reader may have noticed that there are  alternate ways to
accomplish the job of MEASURE_ANALOG_PULSE without the unusual CASE
statement constructs.  For example, the procedure ANALYZE_DATA
could have been written in a straightforward manner and then sprinkled
with calls to a procedure CHECK_PERIPHERALS to make sure that peripherals
```

Listing 1 continued:

```
were serviced in a timely fashion (see Listing 2 where this is done
automatically by hardware interupts).
    I used the approach shown here because it more clearly illustrates
the concept of a coroutine and because a cleaner program structure
can be developed if interlaced procedure calls are avoided.  This
program could be easily modifed to do different or more extensive
data analysis.  *)
```

Listing 2: *Able to handle the data-collection task outlined in listing 1, this program is based on interrupt-driven-I/O techniques.*

```
PROGRAM MEASURE_ANALOG_PULSE_USING_INTERRUPTS;

(*   This listing illustrates a solution to the same real-time problem treated
in Listing 1, but here we use interrupt driven I-O rather than programmed I-O.
Three types of interrupt situations are illustrated: 1) A case where random
inputs must be captured (the keyboard input in the present example).  2) A
case where a peripheral is allowed to interrupt when there is work for it to
do, but not allowed to interrupt otherwise (outputting results to a listing
device here).  3) A case where an interrupt from one device (the clock in our
example) sets up another device (the A-D converter) to interrupt later.
     The program is written in Pascal for general readablity and because it
should be every programmer's goal to do as much programming as possible in
high level languages.  However, interrupts are intimately associated with the
hardware in a system, so there are restrictions on the types of high level
languages that can be used in an interrupt driven environment.  First, you must
have some way of including assembly language instructions and/or procedures in
your program.  Second, the language should be of the direct compiling type
since interpreters (e.g., p-code interpreters) are normally not written using
reentrant code (in this case, interrupt service routines have to be written
entirely in machine code so they won't trash the interpreter temporary storage
locations).  Third, if you are using a multi-user operating system or any
other operating system designed to run with the interrupt on (e.g., RT-11 for
the LSI-11 CPU's) then you must respect and understand the operating system's
interrupt environment.
     In this example, I have assumed that a direct compiling Pascal (such as
Pascal/Z or Pascal/MT+) is being used with an operating system that does not
support interrupt driven I-O (e.g., standard CP/M).  I have further assumed
that there is a priority interrupt scheme such that the clock interrupts have
the highest priority.  *)

(*   Three FIFO buffers are used: one for the A-D values, one for keyboard
input, and one for lister output.  The first part of the definitions is
related to implementing these buffers. Buffers are implemented exactly as in
Listing 1.  *)
CONST
        A_D_BUF_LENGTH = 100;
        KEY_BUF_LENGTH = 20;
        OUT_BUF_LENGTH = 200;
        LONGEST_BUFFER = 200;
TYPE
    BUFFER_HEADER = RECORD
        INPUT_POINTER,
        OUTPUT_POINTER,
        BUFFER_LENGTH : INTEGER;
        BUFFER_FULL,
        BUFFER_EMPTY : BOOLEAN
        END;
(*   The Buffer Header keeps the current status of a FIFO buffer.  The
input pointer points to the next location to be filled, and the output
pointer is the next location to be read from the buffer. *)
    FIFO_BUFFER = ARRAY[1..LONGEST_BUFFER] OF INTEGER;
    STRING20 = ARRAY[1..20] OF CHAR;
VAR
    A_D_HEADER,
    KEY_HEADER,
    OUT_HEADER : BUFFER_HEADER;
    A_D_BUFFER ,
    KEY_BUFFER ,
    OUT_BUFFER : FIFO_BUFFER;
(* End of buffer definitions & start of Globals needed by other procedures. *)
    LIST_FILE : TEXT; (* File var for the listing device *)
    LISTER_INTERRUPT_OFF, (* Boolean used control list device interrupts *)
    ERROR, DONE : BOOLEAN; (* Booleans to control program termination *)
(* The following variables are used in the data analysis *)
    THRESHOLD, PULSE_COUNT : INTEGER;
    PULSE_SUM, AVERAGE_PULSE_HEIGHT : REAL;
    LAST_VALUE_WAS_OVER_THESHOLD : BOOLEAN;

(* The following three procedures implement the FIFO buffers *)

PROCEDURE INIT_BUFFER(VAR B_HEADER : BUFFER_HEADER; B_LENGTH : INTEGER);
BEGIN
    WITH B_HEADER DO BEGIN
        INPUT_POINTER:=1; (* Next location to be filled *)
        OUTPUT_POINTER:=1; (* Next location to be read *)
        BUFFER_LENGTH:= B_LENGTH;
        BUFFER_FULL:= FALSE;
        BUFFER_EMPTY:= TRUE
    END
END;

PROCEDURE STORE(VAR B_HEADER : BUFFER_HEADER;
                VAR BUFFER : FIFO_BUFFER;
                VALUE : INTEGER);
BEGIN
    WITH B_HEADER DO IF NOT BUFFER_FULL THEN BEGIN
        BUFFER[INPUT_POINTER]:= VALUE;
        IF INPUT_POINTER = BUFFER_LENGTH
            THEN INPUT_POINTER:= 1
            ELSE INPUT_POINTER:= INPUT_POINTER+1;
        BUFFER_FULL:= INPUT_POINTER = OUTPUT_POINTER;
        BUFFER_EMPTY:= FALSE
    END
END;

FUNCTION RETRIEVE(VAR B_HEADER : BUFFER_HEADER;
                  VAR BUFFER : FIFO_BUFFER) : INTEGER;
BEGIN
    WITH B_HEADER DO IF NOT BUFFER_EMPTY THEN BEGIN
        RETRIEVE:= BUFFER[OUTPUT_POINTER];
        IF OUTPUT_POINTER = BUFFER_LENGTH
            THEN OUTPUT_POINTER:= 1
            ELSE OUTPUT_POINTER:= OUTPUT_POINTER+1;
        BUFFER_EMPTY:= OUTPUT_POINTER = INPUT_POINTER;
        BUFFER_FULL:= FALSE
    END
END;
```

Listing 2 continued on page 468

Listing 2 continued:

```
(*   All procedures from here to WRITE_CRLF_TO_OUT_BUFFER are hardware and/or
implementation dependent.  Most are shown as stubs with descriptions of what
they have to do, but necessary code is also shown.  *)

PROCEDURE INIT_LIST_FILE;
BEGIN
    (* This procedure should initialize the file variable, LIST_FILE,
    to the listing device; e.g. ASSIGN(LIST_FILE,'LST:'); etc... *)
END;

(*   The procedures shown from here to RESET_ALL_PERIPHERALS are device
dependent.  These procedures set up the peripherals to generate interrupts to
the proper service routine.  The setup routines usually must: 1) give the
peripheral device its interrupt vector location, 2) place the address of the
service routine in memory at the proper vector location, and 3) send command
code(s) to the peripheral to set it in the proper operating mode.  For those
devices where the interrupt must be turned on and off by the program, setup
still takes place as above except the command that enables the peripheral
interrupt is placed in a separate procedure.  Example, the Z80 PIO (parallel I-
O) chip interrupt can be enabled by the command byte 83 hex and disabled by 03
hex without interfering with its already programmed operating mode.  *)

PROCEDURE SET_CPU_INTERRUPT_MODE;
BEGIN
    (* Some CPU's (the Z80, for example) have different interrupt modes
    or have to be initialized in some special way to deal with interrupts.
    For an 8080 CPU nothing needs to be done here since that processor
    has only one interrupt mode.  *)
END;

PROCEDURE START_CLOCK;
BEGIN
    (* Set up the clock to generate an interrupt to the procedure
    SERVICE_CLOCK whenever the A-D needs to be read, and start the clock *)
END;

PROCEDURE SET_UP_A_TO_D;
BEGIN
    (* Set up the A-D so that it generates an interrupt to the procedure
    SERVICE_A_TO_D at end of conversion.  No conversion is started here,
    however.  *)
END;

PROCEDURE START_A_TO_D;
BEGIN
    (* Initiate an analog to digital conversion. *)
END;

FUNCTION READ_A_TO_D : INTEGER;
BEGIN
    (* Reads the A-D and returns a value from 0 to 4095 *)
END;

PROCEDURE SET_UP_KEYBOARD;
BEGIN
    (* Set up the keyboard interface so that it generates an interrupt
    to the procedure SERVICE_KEYBOARD whenever a character is recieved
    from the keyboard.  *)
END;

PROCEDURE SET_UP_LISTER;
BEGIN
    (* Set up the list device interface so that it is capable of generating
    an interrupt to the procedure SERVICE_LISTER when the listing device
    is ready for another character, but do not actually enable lister
    interrupts here since we won't have anything to print until later
    when some results are generated.  The global Boolean variable
    LISTER_INTERRUPT_OFF lets the output routine know when the interrupt
    needs to be turned on.  Thus,  *)
    LISTER_INTERRUPT_OFF:= TRUE
END;

PROCEDURE PRINT_CHAR_AND_ENABLE_LISTER_INTERRUPT( C : CHAR);
BEGIN
    (*  This procedure is called when the list device interrupt is
    not enabled and we want to start listing results.  Here we
    print a character to get things going (the list device will
    always be ready to print when this procedure is called), and
    then enable the lister interface so that it interrupts to
    SERVICE_LISTER when it's ready for another character.  *)
    WRITE(LIST_FILE,C);
    (* Enable lister interrupts here *)
    LISTER_INTERRUPT_OFF:= FALSE
END;

PROCEDURE TURN_OFF_LISTER_INTERRUPTS;
BEGIN
    (*  This procedure is called by the lister interrupt service routine
    when it gets an interrupt but has nothing left to print in its buffer.
    The procedure justs disables list device interrupts, and:  *)
    LISTER_INTERRUPT_OFF:= TRUE
END;

PROCEDURE RESET_ALL_PERIPHERALS;
BEGIN
    (* This procedure is called just before the end of the program.
    It should set up all peripherals so that they are as the normal
    operating system expects to find them (e.g., keyboard interrupts
    should be disabled for most operating systems).  *)
END;

(*  The following procedures are utility routines that are needed
to deal with interrupts.  They will generally have to be written in assembly
language; most Pascal compilers allow you to insert in-line assembly code
into programs and most allow you to externally compile assembly language
procedures.  *)
PROCEDURE ENABLE_INTERRUPTS;
BEGIN
    (* Enable CPU interrupt *acknowledge. Always a single assembly language
    instruction  (e.g., EI in 8080 and Z80 assembly language).  *)
END;
PROCEDURE DISABLE_INTERRUPTS;
BEGIN
    (* Disable CPU interrupt acknowledge ( DI in 8080 and Z80 code). *)
END;

PROCEDURE SAVE_REGISTERS;
BEGIN
    (* This is a crucial procedure.  Its function is to save CPU registers
    and any temporary locations used by both the main routines and by
```

Listing 2 continued:

```
    interrupt service routines.  This procedure should also do whatever your
    CPU and peripherals need to let them know that the interrupt is being
    serviced.  If more than one device can interrupt at a time (i.e., if a
    priority interrupt scheme is used, as assumed in this example) then the
    registers need to be saved on a stack rather than in local variables.
    As an example, the following would work for Z80 CPU's:
        EX      (SP),HL ;Get our return address & push (i.e., save) HL.
        PUSH    AF      ;Save A reg & flags
        PUSH    BC      ;Save BC
        PUSH    DE      ;& DE.
        PUSH    HL      ;Now push our return address back on the stack, &
        RETI            ;let peripherals know interrupt is being serviced.

    Note that the above takes 10 bytes of stack space, plus whatever stack
    space the service routine uses, plus whatever stack space any routine
    that interrupts this one uses.  In other words, you must ALWAYS have
    lots of extra stack available (Pascal is good about this, but operating
    systems sometimes switch to a small local stack when performing services
    for you); or you can switch to a local stack pointer here.
       Most CPU's turn the interrupt off when servicing an interrupt; we'll
    turn it on later before returning from the interrupt service routines. *)
END;

PROCEDURE RESTORE_REGISTERS;
BEGIN
    (*  This procedure is called just before returning from an interrupt
    service routine to put the machine back into its original state:
    I.e.,
        POP     HL      ;First get this routine's return address off stack.
        POP     DE      ;Next, we get reg's off stack in reverse order
        POP     BC
        POP     AF
        EX      (SP),HL ;Finally, get old HL & push current return address.
        RET             ;We already did the RETI in SAVE_REGISTERS.  *)
END;

(*  The following procedures are the interrupt service routines; they
are presented in order from the simplest to the trickiest.
    There are a few general rules for interrupt service routines that will
avoid most common pitfalls.  First, you never know where the main program is
going to be interrupted, so save all registers and avoid calling non-reentrant
routines that are also used elsewhere (e.g., multiple run-time routines are
typically not written in reentrant code even if the Pascal procedures
themselves are reentrant; avoid doing anything in the service routine that does
not generate in-line code).  Second, where the same procedures must be called
from both the main program and interrupt routines (as in the calls to the
buffer handling routines in this program) make sure to turn off the interrupt
in the main program around sections of code where the same variables might be
accessed by a service routine; don't be afraid to bracket short sections of
code with disable-enable interrupt instructions - better safe than sorry.
Third, in a priority interrupt scheme, remember that a service routine might be
interrupted by a higher prioity device.  Lastly, for devices capable of
interrupting frequently, make sure that the device does not interrupt its own
service routine; the service routine itself may be reentrant (the ones shown
here are) but the FIFO buffers are not! - A device interrupting its own service
routine will either corrupt the buffer pointers or will put data into the
buffer in the wrong order.  *)

PROCEDURE SERVICE_KEYBOARD;
VAR     C : CHAR;
BEGIN
    SAVE_REGISTERS;
    READ(C); (* Leave interrupts off until we finish the read since
    the operating system routines might be short on free stack. *)
    ENABLE_INTERRUPTS; (* We can allow higher priority devices to
    interrupt this service routine now if they need to. *)
    ERROR:= ERROR OR KEY_HEADER.BUFFER_FULL;
    STORE(KEY_HEADER,KEY_BUFFER,ORD(C)); (* No need to turn interrupts off
    around this call since any routine that interrupts this one and wants to
    use the buffer handling routines will be using a different buffer header.
    The FIFO buffer routines are reentrant with respect to separate buffers.*)
    RESTORE_REGISTERS
END;

PROCEDURE SERVICE_LISTER;
VAR     C : CHAR;
BEGIN
    (* This procedure is called on a list device ready interrupt.
    If the output buffer is empty then the lister interrupts are
    turned off, otherwise the next character is printed. *)
    SAVE_REGISTERS;
    ENABLE_INTERRUPTS; (* Clock can interrupt now if it wants *)
    IF OUT_HEADER.BUFFER_EMPTY
        THEN TURN_OFF_LISTER_INTERRUPTS
        ELSE BEGIN
            C:= CHR(RETRIEVE(OUT_HEADER,OUT_BUFFER));
            DISABLE_INTERRUPTS; (* No interrupts while using operating system
            services due to possible shortage of stack space. *)
            WRITE(LIST_FILE,C);
            ENABLE_INTERRUPTS
        END;
    RESTORE_REGISTERS
END;

PROCEDURE SERVICE_CLOCK;
BEGIN
    (*  This is the highest priority device; it will interrupt the main
    program or any other service routine whenever it needs to, if CPU
    interrupts are enabled.  All it does is start the A-D conversion;
    reading the A-D is done by the A-D interrupt service routine
    when conversion is complete. *)
    SAVE_REGISTERS;
    START_A_TO_D;
    ENABLE_INTERRUPTS;
    RESTORE_REGISTERS
END;

PROCEDURE SERVICE_A_TO_D;
VAR     A_D_VALUE : INTEGER;
BEGIN
    SAVE_REGISTERS;
    A_D_VALUE:= READ_A_TO_D;
    (* If multiple A-D channels were being sampled, a new conversion
    could be started here to read the next channel. *)
    ENABLE_INTERRUPTS;
    ERROR:= ERROR OR A_D_HEADER.BUFFER_FULL;
    STORE(A_D_HEADER,A_D_BUFFER,A_D_VALUE);
    RESTORE_REGISTERS
END;

(* The following three procedures set up the output buffer for the listing
device; they are implementation, but not hardware, dependent. *)
```

Listing 2 continued on page 470

Listing 2 continued:

```
PROCEDURE WRITE_STRING_TO_OUT_BUFFER(VAR STRING : STRING20);
(* This procedure puts the characters into the output buffer until
it encouters a "$". *)
VAR     I : INTEGER;
        C : CHAR;
BEGIN
    I:=1;
    REPEAT
        C:= STRING[I];
        I:= I+1;
        IF C <> '$' THEN BEGIN
            ERROR:= ERROR OR OUT_HEADER.BUFFER_FULL;
            DISABLE_INTERRUPTS; (* We cannot let the printer interrupt
            while the output buffer pointers are being updated. *)
            STORE(OUT_HEADER,OUT_BUFFER,ORD(C));
            ENABLE_INTERRUPTS
        END
    UNTIL (I=21) OR (C='$') OR ERROR;
(* Now we need to start printing if we actually put something in the
output buffer and the lister isn't already going. *)
IF NOT OUT_HEADER.BUFFER_EMPTY AND LISTER_INTERRUPT_OFF
    THEN PRINT_CHAR_AND_ENABLE_LISTER_INTERRUPT
                            (CHR(RETRIEVE(OUT_HEADER,OUT_BUFFER)))
END;

PROCEDURE WRITE_CRLF_TO_OUT_BUFFER;
VAR     LOCAL_STRING : STRING20;
BEGIN
    LOCAL_STRING[1]:= CHR(13); (* Carriage return *)
    LOCAL_STRING[2]:= CHR(10); (* Line feed *)
    LOCAL_STRING[3]:= '$'; (* String terminator *)
    WRITE_STRING_TO_OUTPUT_BUFFER(LOCAL_STRING)
END;

PROCEDURE WRITE_INTEGER_TO_OUT_BUFFER(VALUE : INTEGER);
VAR     LOCAL_STRING : STRING20;
BEGIN
    (*  In this routine, the integer character string, followed by a space,
    and a "$" should be written to LOCAL_STRING. Then:  *)
    WRITE_STRING_TO_OUT_BUFFER(LOCAL_STRING)
END;

(* The following procedure sets everything up and is only called once *)

PROCEDURE INITIALIZE_PROGRAM;
BEGIN
    INIT_BUFFER(A_D_HEADER,A_D_BUF_LENGTH);
    INIT_BUFFER(KEY_HEADER,KEY_BUF_LENGTH);
    INIT_BUFFER(OUT_HEADER,OUT_BUF_LENGTH);
(* Initialize variables *)
    INIT_LIST_FILE;
    DONE:= FALSE;
    ERROR:= FALSE;
    LAST_VALUE_WAS_OVER_THRESHOLD:= FALSE;
    THRESHOLD:= 2000;
    PULSE_SUM:= 0.0;
    PULSE_COUNT:= 0;
    WRITE('Hit RETURN when ready to start'); (* File var OUTPUT is assumed
    to be the console screen *)
    READLN; (* File var INPUT is assumed to be the keyboard *)
    START_CLOCK;
    SET_UP_A_TO_D;
    SET_UP_KEYBOARD;
    SET_UP_LISTER;
    SET_CPU_INTERRUPT_MODE;
    ENABLE_INTERRUPTS
END;

PROCEDURE ANALYZE_DATA;
VAR     C : CHAR;
        END_PULSE,
        SUPRA_THRESHOLD : BOOLEAN;
        A_D_VALUE : INTEGER;

    PROCEDURE DO_END_PULSE_DATA_ANALYSIS;
    BEGIN
        AVERAGE_PULSE_HEIGHT:= PULSE_SUM/PULSE_COUNT;
        WRITE_INTEGER_TO_OUT_BUFFER(PULSE_COUNT);
        WRITE_INTEGER_TO_OUT_BUFFER(ROUND(AVERAGE_PULSE_HEIGHT));
        WRITE_CRLF_TO_OUT_BUFFER;
        PULSE_COUNT:= 0;
        PULSE_SUM:= 0.0
    END;

BEGIN
    IF NOT KEY_HEADER.BUFFER_EMPTY THEN BEGIN
        C:=CHR(RETRIEVE(KEY_HEADER,KEY_BUFFER));
        DONE:= NOT (C IN ['0'..'9']);
        IF NOT DONE THEN BEGIN
            THRESHOLD:= (ORD(C)-ORD('0')+1)*400;
            WRITE_STRING_TO_OUT_BUFFER('New Threshold= $    ');
            WRITE_INTEGER_TO_OUT_BUFFER(THRESHOLD);
            WRITE_CRLF_TO_OUT_BUFFER
        END
    END;
    IF NOT A_D_HEADER.BUFFER_EMPTY THEN BEGIN
        DISABLE_INTERRUPTS; (* We cannot have the A-D interrupting
        and trying to update the pointers in the A-D buffer while
        we are trying to do the same thing here. *)
        A_D_VALUE:= RETRIEVE(A_D_HEADER,A_D_BUFFER);
        ENABLE_INTERRUPTS;
        SUPRA_THRESHOLD:= A_D_VALUE >= THRESHOLD;
        END_PULSE:= LAST_VALUE_WAS_OVER_THRESHOLD AND NOT SUPRA_THRESHOLD;
        LAST_VALUE_WAS_OVER_THRESHOLD:= SUPRA_THRESHOLD;
        IF END_PULSE THEN DO_END_PULSE_DATA_ANALYSIS
        ELSE IF SUPRA_THRESHOLD THEN BEGIN
            PULSE_COUNT:= PULSE_COUNT+1;
            PULSE_SUM:= PULSE_SUM + A_D_VALUE
        END
    END
END;

BEGIN
    INITIALIZE_PROGRAM;
    REPEAT
        ANALYZE_DATA
    UNTIL DONE OR ERROR;
WHILE NOT LISTER_INTERRUPT_OFF DO ; (* Loop til all printing is done. *)
DISABLE_INTERRUPTS;
RESET_ALL_PERIPHERALS; (* So the operating system finds them as it expects *)
IF ERROR THEN WRITELN('Buffer overflow abort.')
END.
```

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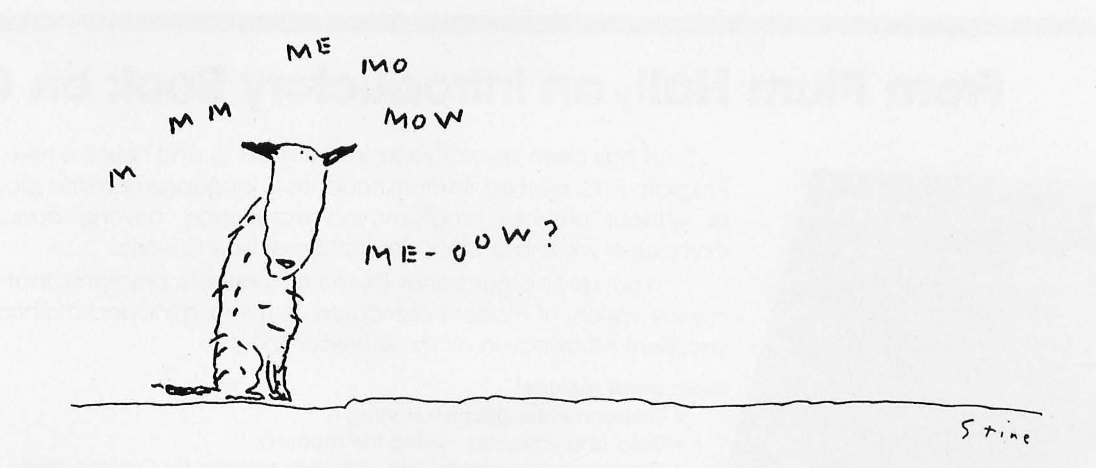
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Regression Fitting to Economic Indexes

An Apple II program can help determine base rates of inflation through analysis of the Consumer Price Index.

Dr. John R. Merrill
Hendrix College
Conway, AR 72032

An interesting application of regression analysis fits an exponential curve to indexes such as the Consumer Price Index (CPI). Such fits provide historical information on prices and can also be used to extrapolate from recent behavior to future performance. Working with such regression analyses demonstrates determining the base rate of inflation despite variations on top of the base rate. The method and the program also suit analysis of many other interesting national indexes.

The Program

Although written for an Apple II computer with 48K bytes of RAM (random-access read/write memory), the program (see listing 1) can run with less RAM if you limit the amount of historical data stored or if you choose not to plot the results. This latter option releases the high-resolution memory space.

In the program, the matrix designated CPI(26,12) stores 26 years' worth (1955 through 1980) of monthly CPI data (lines 570 through 820), here taken from the *Business Conditions Digest*, published by the Bureau of Economic Analysis, U.S. Department of Commerce. The vector Y(26) stores the years of the data.

Lines 40 through 60 read in the values of the CPI and the corresponding years. Line 70 allows you to choose just to fit the data or to fit and plot it. Lines 90 and 100 allow selection of the starting and ending months and years, thereby permitting a subset of data values to be used in calculations.

Lines 170 through 320 form the subroutine that fits the best compound-interest curve to the chosen data. The routine's analysis is based on a linear-regression fit to the natural logarithms of the CPI data. In a sense, the analysis fits the best exponential curve to the raw CPI data for the years and months chosen, using logarithmic weighting factors.

Program variable XS sums the time, measured in years; YS sums the natural logarithms of the corresponding CPI values. Variable XY sums the products of times and logarithms; X2 sums the squares of the times. Lines 280 and 290 use these variables to calculate the best values of the slope M and the intercept B of the straight line representing the logarithm of the CPI as a function of time. The variable R is the best value, according to the least-squares criterion, of the compound rate of increase.

Lines 330 through 520 form a subroutine that plots the chosen data in high-resolution graphics. Note that line 340 finds the best-fit curve using the subroutine beginning at line 170. C0 and C9 are the bottom and top values for the graph. In lines 450 and 460, the variables X9 and Y9 are the points to be plotted. Again notice that the graph is a plot of the natural logarithms of the CPI against time. Lines 490 through 510 plot the best-fit line calculated by the line 170 subroutine.

The Regression Fit

Using a least-squares criterion, the program fits the logarithms of the CPI to a straight line. This fit is equivalent to fitting, by a regression analysis, the raw CPI data to an exponential curve, $y = Ce^{Mt}$, where C and M are the best-fit constants and t is the time.

This fit is equivalent to fitting the data to a compound-interest curve, $y = C(1 + R)^t$, where C is the same constant (notice the values at $t = 0$) and R is the compound-interest rate. If $Ce^{Mt} = C(1 + R)^t$, then $\log(C) + Mt = \log(C) + t\log\ (1 + R)$, where log stands for the natural

---

About the Author

John Merrill has used computers in his teaching at Dartmouth, Florida State, and Hendrix. He has published a book, Using Computers in Physics, *and several monographs and journal articles. His present interests are uses of DEC VAX-11 systems and microcomputer systems.*

logarithm, matching the BASIC notation. Thus, M = log (1 + R), so that R = $e^M - 1$, which is the equation used in program line 300. In program line 290, the variable B is the best value of log(C).

The details of linear-regression analysis, including information on how to calculate the best values of M and B, are discussed in many statistical-analysis books. One such source is Hugh D. Young's *Statistical Treatment of Experimental Data* (McGraw-Hill, 1962), pages 145 and 146.

Program Results

Figures 1 and 2 illustrate program results. Figure 1 shows the fit of (the natural logarithm of) the CPI from January 1955 through December 1980. Because the CPI has several very different base rates of increase over that period of time, the best-fit line (a compound rate of increase of 4.2 percent per year) does not represent the data very well.

Figure 2, on the other hand, shows a fit for January 1955 through June 1956 (a period with little change in the CPI), and were the corresponding graph displayed, this fit would represent the CPI variation quite well with a compound rate of increase of 0.7 percent per year. The second half of the run in figure 2 and the plot shown there are the fit of the CPI from June 1978 through December 1980. Here, the compound rate of increase is 12.7 percent per year, and the straight line is a good representation of the actual base rate of inflation throughout this period. You can also see the relatively small variations around the base-rate line. A number of the points, which represent the raw CPI values, are covered by the best-fit line. This covering is quite clear on the video screen because the program plots the monthly points and then draws the line right over them. To estimate where the covered points lie, remember that the CPI values come in equal steps in time (every month).

Conclusion

The program reported in this note represents one illustration of an instructive application of regression

Listing 1: *This Apple II BASIC program fits the natural logarithms of Consumer Price Index data to a straight line and displays the results. Plotting is user-selectable.*

```
10  REM  CONSUMER PRICE INDEX
20  DIM CPI(26,12),Y(26)
30  REM  READ IN CPI DATA; NYR=# OF YRS OF DATA; YRO=1ST YEAR
40 NYR = 26
50  FOR I = 1 TO NYR: READ Y(I): FOR J = 1 TO 12: READ CPI(I,J)
60  NEXT J: NEXT I:YRO = Y(1)
70  PRINT : INPUT "STOP(0), FIT EXPONENT(1), PLOT(2)?";CC
80  IF CC = 0 THEN  END
90  PRINT : INPUT "1ST MO, YR (I.E. 6,1965)?";M1,Y1
100  INPUT "2ND MO, YR (YR2>YR1)?";M2,Y2
110  PRINT "FROM ";M1;"/";Y1;" TO ";M2;"/";Y2;":"
120 Y1 = Y1 - YRO + 1:Y2 = Y2 - YRO + 1
130  IF Y2 < = Y1 THEN  PRINT "***CAN'T DO.": GOTO 90
140  IF CC = 1 THEN  GOSUB 170: GOTO 70
150  IF CC = 2 THEN  GOSUB 330: GOTO 70
160  GOTO 70
170  REM  SUBROUTINE TO CALC BEST LINE
180 T = 0:XS = 0:YS = 0:XY = 0:X2 = 0
190  FOR I = Y1 TO Y2: FOR J = 1 TO 12
200  IF (I = Y1) AND (J < M1) THEN 260
210  IF (I = Y2) AND (J > M2) THEN 260
220 T = T + 1:X = T / 12:Y =  LOG (CPI(I,J))
230 XS = XS + X:YS = YS + Y:XY = XY + X * Y:X2 = X2 + X * X
240  IF (I = Y1) AND (J = M1) THEN X6 = X
250  IF (I = Y2) AND (J = M2) THEN X7 = X
260  NEXT J: NEXT I
270  REM  M='BEST' SLOPE; B='BEST' INTERCEPT
280 M = (T * XY - XS * YS) / (T * X2 - XS * XS)
290 B = (YS * X2 - XY * XS) / (T * X2 - XS * XS)
300 R =  INT (1000 * ( EXP (M) - 1) + .5) / 10
310  PRINT "  EFF. COMPOUND ANNUAL RATE = ";R;" %"
320  RETURN
330  REM  SUBROUTINE TO PLOT LN(CPI) VS TIME
340  GOSUB 180
350  REM  CO=BOTTOM OF GRAPH; C9=TOP OF GRAPH
360 CO =  LOG ( INT (CPI(Y1,M1))): IF CO < (M * X6 + B) THEN 380
370 CO =  LOG ( INT ( EXP (M * X6 + B)))
380 C9 =  LOG ( INT (CPI(Y2,M2) + 1)): IF C9 > (M * X7 + B) THEN 400
390 C9 =  LOG ( INT ( EXP (M * X7 + B) + 1))
400  HGR : HCOLOR= 3: HPLOT 0,0 TO 279,0 TO 279,159 TO 0,159 TO 0,0
410  PRINT "Y SCALE: LOG("; EXP (CO);") TO LOG("; EXP (C9);")."
420 T = 0: FOR I = Y1 TO Y2: FOR J = 1 TO 12
430  IF (I = Y1) AND (J < M1) THEN 480
440  IF (I = Y2) AND (J > M2) THEN 480
450 T = T + 1:X9 = ((T / 12) - X6) / (X7 - X6)
460 Y9 = ( LOG (CPI(I,J)) - CO) / (C9 - CO)
470  HPLOT 279 * X9,159 - 159 * Y9
480  NEXT J: NEXT I
490 Y6 = ((M * X6 + B) - CO) / (C9 - CO)
500 Y7 = ((M * X7 + B) - CO) / (C9 - CO)
510  HPLOT 0,159 - 159 * Y6 TO 279,159 - 159 * Y7
520  INPUT "  PRESS RETURN FOR NEW COMMAND.";Y$: TEXT : RETURN
530  REM  CPI DATA; EACH ROW: YEAR,12 MONTHLY VALUES
540  REM  VALUES FROM 1/1955 THROUGH 12/1980
550  REM  VALUES FROM 'BUSINESS CONDITIONS DIGEST'
560  REM  US DEPT OF COMMERCE, BUREAU OF ECONOMIC ANALYSIS
570  DATA  1955,80.1,80.1,80.1,80.1,80.1,80.1,80.4,80.2,80.5,80.5,80.6,80.4
580  DATA  1956,80.3,80.3,80.4,80.5,80.9,81.4,82,81.9,82,82.5,82.5,82.7
590  DATA  1957,82.8,83.1,83.3,83.6,83.8,84.3,84.7,84.8,84.9,84.9,85.2,85.2
600  DATA   1958,85.7,85.8,86.4,86.6,86.6,86.7,86.8,86.7,86.7,86.7,86.8,86.7
610  DATA  1959,86.8,86.7,86.7,86.8,86.9,87.3,87.5,87.4,87.7,88,88,88
```

Listing 1 continued:

```
620  DATA  1960,87.9,88,88,88.5,88.5,88.7,88.7,88.7,88.8,89.2,89.3,89.3
630  DATA  1961,89.3,89.3,89.3,89.3,89.3,89.4,89.8,89.7,89.9,89.9,89.9,89.9
640  DATA  1962,89.9,90.1,90.3,90.5,90.5,90.5,90.7,90.7,91.2,91.1,91.1,91
650  DATA  1963,91.1,91.2,91.3,91.3,91.3,91.7,92.1,92.1,92.1,92.2,92.3,92.5
660  DATA  1964,92.6,92.5,92.6,92.7,92.7,92.9,93.1,93,93.2,93.3,93.5,93.6
670  DATA  1965,93.6,93.6,93.7,94,94.2,94.7,94.8,94.6,94.8,94.9,95.1,95.4
680  DATA  1966,95.4,96,96.3,96.7,96.8,97.1,97.4,97.9,98.1,98.5,98.5,98.6
690  DATA  1967,98.6,98.7,98.9,99.1,99.4,99.7,100.2,100.5,100.7,101,101.3,101.6
700  DATA  1968,102,102.3,102.8,103.1,103.4,104,104.5,104.8,105.1,105.7,106.1,106.4
710  DATA  1969,106.7,107.1,108,108.7,109,109.7,110.2,110.7,111.2,111.6,112.2,112.9
720  DATA  1970,113.3,113.9,114.5,115.2,115.7,116.3,116.7,116.9,117.5,118.1,118.5,119.1
730  DATA  1971,119.2,119.4,119.8,120.2,120.8,121.5,121.8,122.1,122.2,122.4,122.6,123.1
740  DATA  1972,123.2,123.8,124,124.3,124.7,125,125.5,125.7,126.2,126.6,126.9,127.3
750  DATA  1973,127.7,128.6,129.8,130.7,131.5,132.4,132.7,135.1,135.5,136.6,137.6,138.5
760  DATA  1974,139.7,141.5,143.1,143.9,145.5,146.9,148,149.9,151.7,153,154.3,155.4
770  DATA  1975,156.1,157.2,157.8,158.6,159.3,160.6,162.3,162.8,163.6,164.4,165.6,166.3
780  DATA  1976,166.7,167.1,167.5,168.2,169.2,170.1,171.1,171.9,172.6,173.3,173.8,174.3
790  DATA  1977,175.3,177.1,178.2,179.6,180.6,181.8,182.6,183.3,184,184.5,185.4,186.1
800  DATA  1978,187.2,188.4,189.8,191.5,193.3,195.3,196.7,197.8,199.3,200.9,202,202.9
810  DATA  1979,204.7,207.1,209.1,211.5,214.1,216.6,218.9,221.1,223.4,225.4,227.5,229.9
820  DATA  1980,233.2,236.4,239.8,242.5,244.9,247.6,247.8,249.4,251.7,253.9,256.2,258.4
830  REM  COPYRIGHT (C) HENDRIX COLLEGE 1980
840  REM  ALL RIGHTS RESERVED. PLEASE GIVE APPROPRIATE CREDITS.
850  END
```

(1a)

```
RUN

STOP(0), FIT EXPONENT(1), PLOT(2)?2

1ST MO, YR (I.E. 6,1965)?1,1955
2ND MO, YR (YR2>YR1)?12,1980
FROM 1/1955 TO 12/1980:
  EFF. COMPOUND ANNUAL RATE = 4.2 %
Y SCALE: LOG(68) TO LOG(259).
  PRESS RETURN FOR NEW COMMAND.

STOP(0), FIT EXPONENT(1), PLOT(2)?0

]
```

(1b)

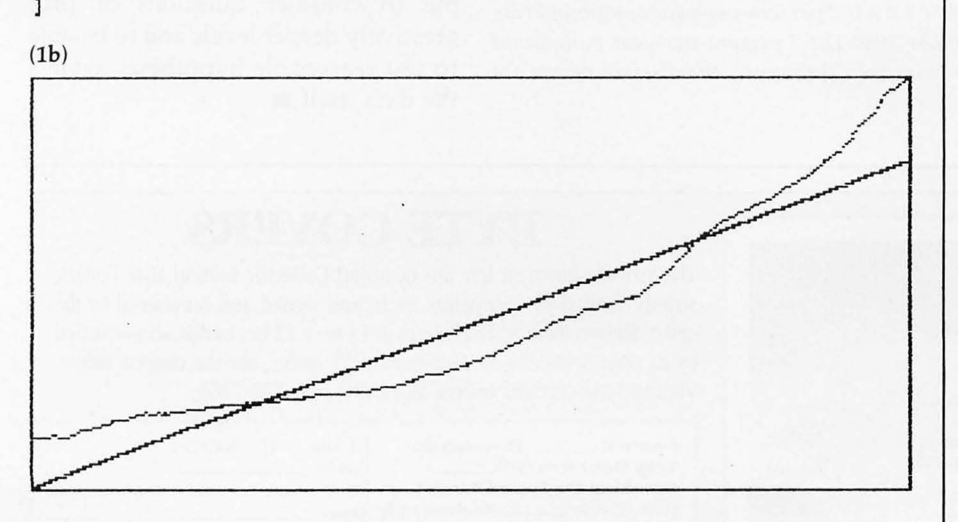


Figure 1: *The computer prompting messages and operator responses shown in (1a) produce the plot shown in (1b). This plot results from running the listing 1 program using Consumer Price Index data from January 1955 through December 1980. The best-fit line represents a 4.2 percent-per-year compound rate of increase.*

(2a)

```
]RUN

STOP(0), FIT EXPONENT(1), PLOT(2)?1

1ST MO, YR (I.E. 6,1965)?1,1955
2ND MO, YR (YR2>YR1)?6,1956
FROM 1/1955 TO 6/1956:
  EFF. COMPOUND ANNUAL RATE = .7 %

STOP(0), FIT EXPONENT(1), PLOT(2)?2
```

(2b)

```
1ST MO, YR (I.E. 6,1965)?6,1978
2ND MO, YR (YR2>YR1)?12,1980
FROM 6/1978 TO 12/1980:
  EFF. COMPOUND ANNUAL RATE = 12.7 %
Y SCALE: LOG(192) TO LOG(260).
  PRESS RETURN FOR NEW COMMAND.

STOP(0), FIT EXPONENT(1), PLOT(2)?0

]
```

(2c)

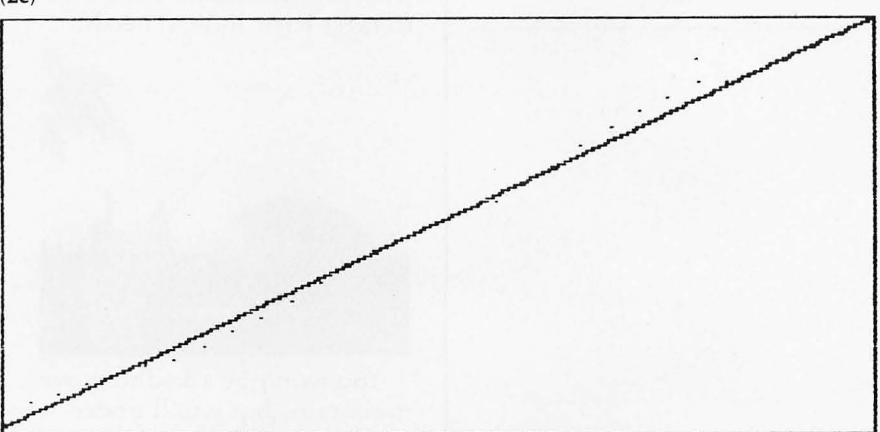


Figure 2: *Demonstrating use of the listing 1 program, the prompting and response messages in (2a) and (2b), respectively, show program operation for Consumer Price Index data from January 1955 through June 1956 (at a 0.7 percent-per-year compound rate of increase) and June 1978 through December 1980 (12.7 percent-per-year compound rate of increase). The graph in (2c) results from the (2b) inputs; the discrete points are individual Consumer Price Index values.*

analysis to curves of general interest. This regression analysis is actually a nonlinear, least-squares fit to an exponential curve representing a compound-interest function. However, the nonlinear regression is accomplished using well-known results from linear-regression analysis by fitting the best straight line to the natural logarithms of the particular index used, the CPI.

Using the program demonstrates the complexity of the CPI as a function of time. Such use also demonstrates that the CPI behavior in specific segments of time can be reasonably well represented by compound-interest curves with differing base annual inflation rates. Furthermore, using the program shows the relatively small variations on top of the base inflation rates in the different epochs.

Such an instructive analysis then leads to the questions that simple data manipulations are *unlikely* to answer—fundamental questions such as, "What occurred during the various, distinct epochs to cause the quite different base inflation rates?" "Can you see the effects of the Vietnam War or the price increase from OPEC in the appropriate epochs?" or "Are the effects of such major influences as war or energy prices delayed in time and why?" The point of the instructive illustration furnished by this program is to get people to consider questions of progressively deeper levels and to be able to test reasonable hypotheses against the data itself.■

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Sorting Algorithms for Microcomputers

Programmer ingenuity and search of the existing literature can significantly improve sort performance.

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Many applications require organizing data into ascending or descending order—sorting. This can be an extremely time-consuming job, especially if a too simple algorithm is used. On a large machine the inefficiency may not be noticed—one second versus ten may not be worth worrying about. On a microcomputer, however, one *minute* versus ten may be quite important, especially if you're sitting at a terminal waiting for the results.

In this article we examine two fairly simple and closely related sorting algorithms: Shuttlesort and Shellsort. Shellsort is a generalization of Shuttlesort, requiring only a small added expenditure of programming effort but yielding astounding improvements in performance.

In addition, we examine the sorts' performance on a variety of machine-language combinations to give some idea of their relative power on a common practical task.

When faced with a common problem such as sorting, someone has probably developed efficient methods—what you need to know is where to look. References 1, 2, 4, and 5 are convenient sources of sorting algorithms.

Types of Sorts

If the sort program and all the data to be sorted fit into central memory, we can use an *internal sort*. If not, some kind of *external sort* must be used. Such sorts involve sorting parts of the data in central memory, writing these sorted parts to a disk, and then merging the parts together to create a file of sorted data. This article deals with internal sorts, which can be used during the internal phase of an external sort.

Many internal sorting algorithms are available, each with advantages and disadvantages. Broadly speaking, we can classify the sorts by two characteristics: efficiency and complexity (see table 1).

Shellsort occupies an interesting position in this classification: it is in the same efficiency class as sorts such as Quicksort yet is easier to program. In addition, it is more efficient than the Shuttle/Bubble varieties yet no more difficult to program. This is only a small exaggeration. Shellsort is slightly more complicated than those in the Shuttle category. Also, it is slightly less efficient, at least theoretically, than Quicksort and Treesort. Nevertheless, in most situations Shellsort represents the best choice in trading machine time for complexity. Furthermore, Shellsort requires no more space than Shuttlesort while Quicksort does require additional space.

About the Authors

Terry Barron is a doctoral candidate in the School of Business at the University of Washington. George Diehr is an Associate Professor of Quantitative Methods in the School of Business at the University of Washington.

	Complexity of Algorithm		
Efficiency	Low	Medium	High
Low	Shuttle Bubble Pair Exchange		
Medium	Shellsort	Quicksort Treesort	
High			Linear-Time Sort

Table 1: *Common sorting methods can be classified by two characteristics: efficiency and complexity.*

Listing 1: *This Applesoft version of Shuttlesort includes a GOSUB at line 20 to branch to code that generates data used to perform the tests described in the text. The sort proper is the code from line 50 through line 200.*

```
10   DIM X(1024)
19   REM   BRANCH TO GENERATE N RANDOM VALUES
20   GOSUB 1000
50   FOR I = 1 TO N - 1
60   FOR J = I TO 1 STEP  - 1
70   IF X(J) < = X(J + 1) THEN 200
80 TX = X(J):X(J) = X(J + 1):X(J + 1) = TX:
100   NEXT J
200   NEXT I
```

Because Shuttlesort serves as the starting point for Shellsort, we consider it first. It is useful for sorting small lists of items (e.g., up to 30 or so on a microcomputer). Shuttlesort is also used as part of more complex algorithms such as modified Quicksort. (Reference 5 is an excellent source for more information on all the sorts noted in the table except the linear-time sort, which is covered in reference 6.)

Shuttlesort

For a concrete demonstration of the Shuttlesort algorithm, we will assume that we want to sort the following list of single characters into normal alphabetical order:

Location	1	2	3	4	5	6
Element	X	C	D	M	A	B

The Shuttlesort algorithm starts by comparing the first two items, X and C, and exchanges them if they are out of order. Because X should come after C, they are exchanged. The algorithm next compares locations 2 and 3. Because X should come after D, they are exchanged.

The sort now determines how far up in the list the value D should be moved (to the left in our display). Therefore, C and D are compared. Because they are in the right order, no exchange is made. The comparisons resume at locations 3 and 4; X should come after M and they are swapped. The list is now

Location	1	2	3	4	5	6
Element	C	D	M	X	A	B

Values at locations 4 and 5 are compared next. Because X should come after A, they are exchanged; next, M and A are compared and another exchange occurs. Two more exchanges—D and A, then C and A—place A in location 1. The sort resumes by comparing X and B. B travels up the list until it stops at location 2, finishing the sort:

Location	1	2	3	4	5	6
Element	A	B	C	D	M	X

Although our example sorts single characters, the algorithm applies equally to real values, integers, or arbitrarily long strings. The performance tests presented here use randomly ordered real values.

Listing 1 shows an Applesoft version of Shuttlesort for real-valued data. The FOR loop from lines 50 to 200 controls the traversal down array X so that the first comparison for a given value of I is X(I) and X(I+1). The inner FOR loop, lines 60 through 100, moves the value at X(I) up the list until it encounters a smaller (or equal) value or until it reaches the top of the list. The exchange of X(J) and X(J+1) in line 80 moves data elements up the list.

As noted in table 1, Shuttlesort is in the same class as the Bubble and Pair Exchange sorts. A sort shown in the *Apple BASIC Programming Reference Manual* (page 15) is a Pair Exchange sort. The efficiency of these sorts can be described by the increase in sorting time as the number of items to be sorted increases. If it takes T seconds to sort N items, these sorts will require about 4T seconds to sort 2N items: the sort time increases with the square of the number of items. Algorithms with this efficiency are said to be *order N-square* in performance. Sorting time can get out of hand very quickly with an order N-square sort. For example, if 100 items require 100 seconds to sort, 200 items will require 400 seconds. Sorting 1000 items becomes impractical—it would take about 3 hours.

A clue to this algorithm's inefficiency can be seen in our letter-sorting example. The value A starts in location 5 but belongs in location 1; Shuttlesort needs four exchanges to move it to the top. Similarly, the movement of value B to location 2 also requires four exchanges. As the number of items to be sorted increases, the number of exchanges for each item increases. The total number of exchanges is proportional to the number of items times the number of exchanges for each—hence the order N-square performance.

Whole List	Before Sublist 1	2	3	4	5	After Sublist 1	2	3	4	5	Whole List
L	L					K					K
W		W					H				H
D			D					D			D
U				U					E		E
P					P					A	A
T	T					L					L
H		H					W				W
N			N					N			N
E				E					U		U
A					A					P	P
K	K					T					T

Figure 1: *Shellsort creates five sublists when distance D=5; each sublist is sorted with a Shuttlesort. Before refers to the data order before the Shellsort pass; After refers to the order resulting from the Shellsort pass.*

Whole List	Before Sublist 1	2	3	After Sublist 1	2	3	Whole List
K	K			E			E
H		H			A		A
D			D			D	D
E	E			K			K
A		A			H		H
L			L			L	L
W	W			P			P
N		N			N		N
U			U			U	U
P	P			W			W
T		T			T		T

Figure 2: *These three Shellsort sublists result when distance D=3. The Before list is identical to figure 1's After list; it results from the D=5 Shellsort.*

If Shuttlesort could move items more than one position at a time, it might be more efficient. One way to make larger moves is to compare items farther apart than just one location. This is the idea behind Shellsort; reference 7 discusses Shell's original work.

Shellsort

Shellsort works by dividing the list of data into sublists. Shuttlesort is used to order each sublist and finally merge them into the final, completely sorted list. The final pass of Shellsort is identical to a Shuttlesort. Earlier passes try to move small values near the top of the list in large steps. On the final (Shuttlesort) pass values don't have far to move.

To demonstrate Shellsort, we use the larger list of data shown in figure 1. Instead of comparing immediate neighbors, the algorithm starts by comparing items some fixed distance apart, 5 for the first figure 1 pass. The Before section shows the original list of data and the five sublists that result when items five locations apart are compared. The algorithm effectively applies a Shuttlesort to each of these sublists. The After section shows the now-ordered sublists and the resulting whole list at the end of the pass. Note that only six comparisons have managed to move letters in the first half of the alphabet to the top half of the list and letters in the last half of the alphabet to the bottom half of the list.

The next pass uses a distance of 3, resulting in the three sublists shown in figure 2. Each sublist is sorted (using Shuttlesort) with the result in the After section. The first quarter of the list now contains letters from the first quarter of the alphabet and so on. The list becomes partially ordered very quickly.

The final pass uses a distance of 1, resulting in only one sublist, the entire list of values. Clearly, applying Shuttlesort to that list assures that the final result is completely ordered. Note the small distance items need to move in this final pass to find their final position; no item need move more than two locations.

The changes required to convert Shuttlesort to Shellsort are minimal. First, lines 50 through 200 in listing 1 are modified to use distance D rather than the fixed distance 1. After each pass, the value of D reduces to INT(D/2) at line 230 of listing 2. When D is reduced to 0, we know that the pass just completed was the Shuttlesort on the whole list. Thus, the sort is complete.

Determining Distances

How do we choose the distances? Although the algorithm's performance is known to be rather sensitive to the distances, there is no known way to select the ones that guarantee minimum sort time. However, the initial distance and all subsequent distances should be odd. One of the most commonly used set of distances with this property was developed by Hibbard (see reference 3). He uses an initial distance of

$$D=2^{INT(LOG(N)/LOG(2))}-1$$

	Shuttlesort		Shellsort	
Number of Items	Number of Comparisons	Number of Exchanges	Number of Comparisons	Number of Exchanges
32	280	251	159	70
64	1050	992	411	180
128	4186	4063	1142	555
256	16,802	16,552	2515	1108
512	64,761	64,255	6395	3089
1024	264,233	263,223	15,740	8131
2048	1,032,218	1,030,176	34,994	17,698
4096	4,141,646	4,137,563	84,969	46,277

Table 2: *Comparing Shellsort with Shuttlesort illustrates the former algorithm's superiority.*

Listing 2: *Comparing this Applesoft version of Shellsort with the listing 1 program demonstrates that only two lines—45 and 230—need be added to a Shuttlesort program to form Shellsort. The variable D generalizes the distance between comparisons; this distance is fixed at 1 in Shuttlesort.*

```
10  DIM X(1024)
19  REM   BRANCH TO GENERATE N RANDOM VALUES
20  GOSUB 1000
45 D = 2 ^  INT ( LOG (N) /  LOG (2)) - 1
50  FOR I = 1 TO N - D
60  FOR J = I TO 1 STEP  - D
70  IF X(J) < = X(J + D) THEN 200
80 TX = X(J):X(J) = X(J + D):X(J + D) = TX
100  NEXT J
200  NEXT I
230 D =  INT (D / 2): IF D > 0 THEN 50
```

Each subsequent distance is

D=INT(D/2)

(Note that LOG(N)/LOG(2) is the base 2 logarithm of N.) The values of D are always of the form 2^P-1 for some positive integer P. For example, if we have 100 items to sort, the initial P is 6 and the initial D is 63. In subsequent passes, D equals 31, 15, 7, 3, and 1. (For our little example, we should have used an initial distance of 7, but we chose 5 to make it a bit more interesting.)

We now have all the parts necessary for the algorithm. The Apple BASIC program is in listing 2.

Performance Evaluation

We claimed in the beginning that Shellsort was well worth the minor programming changes. The acid test of this is the time required to sort. It often turns out that an algorithm that has superior theoretical performance realizes its advantage over another algorithm only for very large values of N. For example, suppose we code an algorithm that is order N—that is, doubling the number of items to sort only doubles the time. But suppose it takes 1000 seconds to sort 100 items, while our order N-square algorithm takes 100 seconds. Sorting 200 items requires 2000 and 400 seconds respectively; sorting 500 items requires 5000 and 2500 seconds respectively. Only when we sort more than 1000 items will the order N algorithm be superior. In such situations, the choice of algorithm depends heavily on the number of items to sort.

Therefore, we compared timings for Shuttlesort and Shellsort for several machines and languages. In addition to time measurements, we also counted the number of exchanges and comparisons required by each method. While the time will certainly differ for different hardware, the counts will not, so they provide insight into algorithm efficiency independent of hardware/software considerations.

Another measure for a sort algorithm is the amount of memory required. Each method requires only minimal extra memory beyond the list to be sorted. Furthermore, this extra space does not increase as the number of items increases. Thus, space use is order N. In contrast, algorithms that are slightly more efficient than Shellsort typically require significant extra space. For example, some require space for pointers—possibly two pointers per item.

For the performance comparisons, random real values were generated. This probably represents the most challenging type of data for both algorithms—with integers or strings, duplicate values are more likely to occur and sort time would be reduced for both.

Table 2 shows the number of comparisons and exchanges for the two algorithms for lists of size 32, 64, . . . 4096. The superiority of Shellsort is obvious throughout. Scanning the Comparisons and Exchanges columns under Shuttlesort reveals its order N-square nature—when N doubles, the number of operations increases fourfold. Also note how the number of exchanges is close to the number of comparisons. Exchanges are expensive—they require three LET statements.

The rate of growth of the number of comparisons and exchanges for

Number of Items	Sort time in seconds for: Shuttlesort	Shellsort
32	7	3.5
64	26	7.5
128	103	20
256	413	51
512	(1652)	121
1024	(6608)	295
2048	(26,433)	(706)
4096	(105,730)	(1692)

Table 3: *Comparison of sort times for Shuttlesort and Shellsort algorithms written in Applesoft BASIC support table 2's indication of Shellsort's superiority. The numbers in parentheses are estimated times.*

Shellsort is far slower. Instead of an order N-square increase, it is approximately proportional to $N^{1.26}$. Thus, doubling N results in an increase of roughly 2.4 times in the number of operations. Furthermore, the number of exchanges is much less than the number of comparisons, usually about half. (Note that different data produce different counts, but the relationships remain approximately equal to those we measured.) These counts show the effectiveness of early passes in moving items a long way up and down the list with few comparisons and exchanges.

From the counts of comparisons and exchanges, Shellsort should be much faster. It is: table 3 shows sort times in seconds for the two algorithms using Applesoft interpreted BASIC. (Some of the times have been estimated because they are so long. The estimation method is described in the next section.) As you can see, as N grows Shuttlesort becomes impractical very quickly: sorting just 256 values requires almost 7 minutes. By comparison, Shellsort can order four times as many values, 1024, in less time. Even though the Apple has enough memory to sort 4096 values, do you have the patience to wait out a Shuttlesort? The estimated time is about 29 hours.

Using Shellsort, it is practical to sit at the machine while it sorts 1024 values. Sorting 2048 values calls for a coffee break (12 minutes), while you might schedule a sort of 4096 values for a quick lunch (about 28 minutes).

Predicting Sort Times

It is quite easy to develop simple and accurate estimates for sort times for both algorithms. Based on the order of the methods, estimates of the following forms are used:

$$\text{Time(Shuttlesort)} = C\,N^2$$
$$\text{Time(Shellsort)} = K\,N^{1.26}$$

The constants C and K are estimated from actual times from table 3. The estimates are usually better if larger values of N are used. For example, using N=256 to estimate C gives

$$C = 413/256^2 = 0.006302$$

Using this value for C gives an estimate for N=128 of

$$\text{Time(Shuttlesort)} = 0.006302*128^2 = 103.25$$

agreeing with our observed time. The estimate for 1024 items is

$$\text{Time(Shuttlesort)} = 0.006302*1024^2 = 6608 \text{ seconds}$$

or almost 2 hours.

For Shellsort, the estimated K using N=1024 is

$$K = 295/128^{1.26} = 0.0475$$

The estimate for sorting 128 values is

$$\text{Time(Shellsort)} = 0.0475*128^{1.26} = 21.5$$

agreeing fairly well with the observed 20 seconds.

Pushing Shellsort Further

Many algorithms can be "tuned" to give additional performance improvement, although often no improvement in order of performance. This is the case with Shellsort. We can reduce times by about 25 percent with the following change: when we find a value that is out of place, say X(I+D), it is stored in TX. TX is then

Listing 3: *In an Applesoft version of Super-Shellsort, exchanges are delayed so that fewer LET statement executions are required than in the usual Shellsort algorithms. This program reduces sort times by about 25 percent compared with the listing 2 program.*

```
10  DIM X(1024)
19  REM   BRANCH TO GENERATE N RANDOM VALUES
20  GOSUB 1000
45 D = 2 ^  INT ( LOG (N) /  LOG (2)) - 1
50  FOR I = 1 TO N - D
55  IF X(I) <  = X(I + D) THEN 200
57 TX = X(I + D):X(I + D) = X(I)
58  IF I <  = D THEN X(I) = TX: GOTO 200
60  FOR J = I - D TO 1 STEP  - D
70  IF TX >  = X(J) THEN 120
80 X(J + D) = X(J)
100  NEXT J
120 X(J + D) = TX
200  NEXT I
230 D =  INT (D / 2): IF D > 0 THEN 50
```

compared up the list, moving displaced values down by distance D until the proper place for TX is found. Thus, moving a value up in M steps requires only M−1 moves and one exchange instead of M exchanges. (This improvement is discussed in reference 3.) This version of the program appears in listing 3.

This tuning reduces the time to sort 1024 values from 295 seconds to 223 seconds. The time to sort 4096 values is now about 20 minutes compared to about 28 minutes.

In theory, there are quicker algorithms than Shell's. For example, based on statistics reported in reference 5 (page A41), Quickersort seems to be about three times faster. However, Quickersort involves significant manipulation of pointers and transfers of control, operations that are especially expensive with an interpreter. We once tried Quickersort on an 8080-based microcomputer using Microsoft BASIC. The results were miserable—the seconds required by Shellsort became minutes with Quickersort. We have not repeated the experiment with the Apple.

The Apple versus IBM and Two of the Dwarfs

How powerful is the Apple? What is the performance gain from compiling? How do BASIC and FORTRAN compare in performance? We did not embark on an exhaustive performance comparison, but having several computer systems available and for some time having harbored suspicions about Grosch's law (explained later) we coded Shuttlesort and Shellsort on several machines using several languages:

- Apple with Applesoft BASIC
- Apple with Microsoft BASIC compiler
- IBM Personal Computer with Microsoft BASIC interpreter
- Digital Equipment Corporation VAX-11/780 with BASIC compiler
- DEC VAX with FORTRAN (compiled)
- Control Data Corporation Cyber 170-750 with BASIC compiler
- CDC Cyber with FORTRAN (optimizing FTN5 compiler)

Table 4 summarizes the results and shows the ratios of sort times for 1024 values using Shellsort. The underlined values represent comparisons that are probably the most accurate reflections of machine power as opposed to comparison of languages or compilers/interpreters. For example, row 2 indicates that the VAX is about 47 times faster than the Apple (both using compiled BASIC). The CDC is somewhere between 2.6 and 4.3 times faster than the VAX depending on whether we compare BASICs or FORTRANs.

If you have a BASIC compiler for your Apple, you probably know

about the significant speed improvements it affords. Using the Microsoft BASIC compiler with integer variables for everything except the actual array of values to be sorted, 1024 values can be sorted in 33 seconds, and 4096 values require 166 seconds (there went your coffee break). The average improvement is a factor of about 7.5.

Now, what about Grosch's law? Herbert Grosch hypothesized a relationship between computer cost and performance that claimed a quadrupling of performance for a doubling of cost (a quadratic relationship). This seemed to hold true for many years, especially if performance was based on measures of raw computing power such as add times. Because internal sorting requires primarily brute computational power, as opposed to input/output operations, our performance measures should be a fair test of the law.

In order to make some sense of cost/performance trade-offs, we calculated for each machine the following quantity:

	Apple BASIC Compiled	IBM PC BASIC	VAX BASIC	VAX FORTRAN	CDC BASIC	CDC FORTRAN
Applesoft	7.6	1.46	360	1100	952	4758
Apple BASIC Compiled		.19	47	145	125	626
IBM PC BASIC			247	753	652	3259
VAX BASIC				3.0	2.6	13.2
VAX FORTRAN					.87	4.3
CDC BASIC						5.0

Table 4: *These relative performance comparisons of various hardware/software combinations are based on sorting 1024 values with Shellsort. Table entries are the ratio of the row-system sort time to the column-system sort time; for example, the VAX BASIC system runs Shellsort 47 times faster than the Apple BASIC Compiled system does. Underlined values are those most appropriate for comparisons of the relative power of different hardware.*

System	Cost	Cost Index
Apple, BASIC	$1500	1.00
VAX, BASIC	$100,000	1.42
VAX, FORTRAN	$100,000	0.47
CDC, BASIC	$1,000,000	5.33
CDC, FORTRAN	$1,000,000	1.06

Table 5: *A comparison of the cost index of various computer systems.*

$$\text{cost index} = \frac{\text{cost of machine X/cost of Apple}}{\text{performance of X/performance of Apple}}$$

Performance is 1/time to sort 1024 items. The results are shown in table 5. The cost index tells how many Apples you could buy for each unit of Apple performance obtained when using specific machine-language combinations. Even more to the point, if you could divide a job into pieces that could be run simultaneously, this indicates that in all cases except the VAX/FORTRAN combination it would be cheaper to buy a bushel of Apples in place of the larger machine. For example, with the CDC/BASIC combination you could buy 5.33 Apples for each unit of Apple performance that the CDC provides. Because the CDC/BASIC combination sorted 1024 values 125 times faster than the Apple, you would spend 125*$1500=$187,000 in Apples versus about $1,000,000 for the CDC.

Although this is certainly a crude comparison, it is quite interesting. If Grosch's law held, we should see the cost index dropping rapidly with increasing machine cost. Because the CDC costs about 667 times as much as the Apple, Grosch's law implies that its performance should be about 444,444 times better, that is, $(1{,}000{,}000/1500)^2 = 444{,}444$. In fact, the CDC performance is at best about 626 times better.

Conclusions

Small changes in a program can yield dramatic performance gains. About the only good reason for ever using one of the order N-square sorting algorithms is for illustrative or educational purposes. Minor tuning can also give significant improvements.

If you do a significant amount of numerical computing and are using an interpreted BASIC, you should probably look into a compiler. The performance improvement is much greater than the gain possible by moving to a faster chip (e.g., a Z80 or 8088 in place of the 6502).

Finally, if you have a spare quarter of a million dollars, you can purchase a machine that will give you a proportional performance improvement over the Apple, but don't expect to reap much in the way of economies of scale. ■

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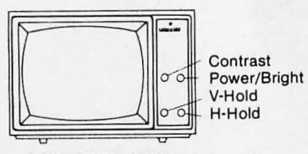
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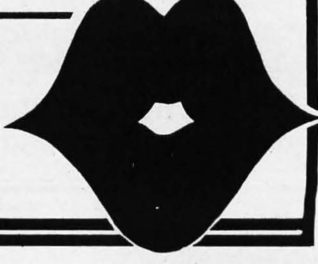
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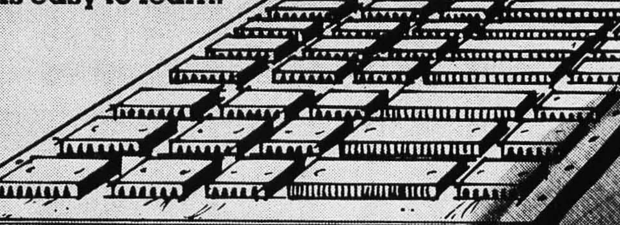
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BYTELINES

News and Speculation about Personal Computing

Conducted by Sol Libes

Random Rumors: American Bell is reportedly readying a desktop workstation computer running the Unix System 5 operating system; it may be introduced this summer. The firm is also expected to introduce a minicomputer in the same class as Digital Equipment Corporation's (DEC's) VAX, as well as several personal computer products. There are rumors that American Bell has had discussions with Fortune Systems to purchase manufacturing rights to the Fortune 32:16 system (see page 82 of this issue for Steven H. Barry's review of the 32:16). . . . Word has it that DEC is working on a desktop version of the VAX; already DEC has produced a "PDP-11-on-a-chip."

Apple Computer Inc. is believed to be working on a DOS (disk operating system) with a file format that will allow files to be moved between the Apple II, Apple IIe, Apple III, and Lisa.

Pick Systems may be close to releasing a version of its popular Pick Operating System for the IBM Personal Computer. . . . Several local telephone companies are reportedly seeking to sell personal computers in their telephone stores. . . . There are rumors that several low-cost portable computers are due here from Hong Kong and Taiwan. The portable market appears to be the hottest, considering the number of new units being introduced this year.

Commodore News: Commodore appears to have scrapped its 16-bit microprocessor, in development for over four years, and has entered into an agreement to manufacture the Zilog Z8000 and related peripheral chips. Apparently, Commodore will use the Z8000 in a new 16-bit personal computer because the agreement allows the company to use the Z8000 chip in its own products only and precludes Commodore from selling it on the open market. The fact that both CP/M and an excellent version of Unix developed by Zilog are already available for the Z8000 may have prompted Commodore's decision; however, little applications software is available for that device.

Apple Doings: At Apple Computer's January stockholders' meetings, Apple formally introduced the Lisa and Apple IIe (see Gregg Williams's review "The Lisa Computer System" and Robin Moore's "Apple's Enhanced Computer: the Apple IIe," pages 33 and 68, respectively, in the February 1983 BYTE). The company disclosed that the last month of Apple II Plus sales (December 1982) was the best they ever had (45,000 units were sold) and that a total of 750,000 Apple IIs had been sold by the end of that month.

Steve Jobs, Apple chairman, announced that Apple would institute a plan to donate 10,000 Apple IIe systems to accredited schools in California. A similar effort to receive federal tax credits for a national program of gifts to schools failed to get through Congress last year.

Apple has also made a request to the U.S. International Trade Commission to investigate "unfair" competition by manufacturers in Hong Kong, Taiwan, Singapore, and Switzerland. Apple alleges patent and copyright infringement and is asking the ITC to bar imports of these Apple II look-alikes. Despite the fact that the Customs Service has already seized a large number of these imports, more and more U.S. companies are importing them.

Radio Shack News: Tandy has announced that it will replace the present operating system used on the Model 16 with Xenix, the Unix-like operating system from Microsoft. It will be furnished to all owners of previously sold Model 16s. This will more than double the number of Xenix users. To run Xenix, a user will need 256K bytes of memory and a hard disk. The standard Unix utilities and software tools are extra. Thus a base-priced system will be over $9000; still a low price for a Unix system. The two companies are also developing a single-user, floppy-disk-based Xenix for mid-1983.

Finally, Tandy, the last hold-out among major suppliers, has agreed to furnish Digital Research's CP/M operating system for the new TRS-80 Model 12 system.

Is Integrated Software the Key to Success? The next generation of personal computers will be here shortly, and it will be characterized by highly integrated software/hardware systems. The first two such systems have already been demonstrated and should be in users' hands in the next two to three months. I am talking about the Apple Lisa, Visicorp's Visi On system, and a new unnamed operating system I am expecting Microsoft to announce shortly.

The new-generation systems offer a high degree of integration between applications software, operating-system software, and hardware. As a result, these systems will create an applications environment. Their common distinctive features are the new user interface, integration of applications programs, and greater reliance on graphics. Up until now, user interfaces have been geared to the programmer, a highly trained user willing to spend many hours studying cryptic manuals; but these new systems are designed with a degree of simplicity rarely seen before; networking and integration of multiple applications such as word processing, data handling, and spreadsheet use are also considered important. Many of these concepts were promoted by Xerox in its Alto system (built for internal use by researchers at Xerox's Palo Alto Research Center) but it now appears that personal computer designers will really bring them into wide use.

These systems encourage the user to view the graphics display as a desktop. Graphic representations of familiar objects (called icons) are visible on the desk, including sheets of paper on top of one another, in and out baskets, a mailbox, file folders, a printer, etc. These are actually windows allowing the user to view simultaneously the execution of multiple applications programs. Users can rearrange the overlapping papers to their hearts' delight and can point to a graphics representation of a desired function using a mouse. There is one icon that is always present, the *Help* icon. (The Visi On system as implemented on the IBM Personal Computer, with limited graphics capability, uses labeled, highlighted boxes instead of icons.)

Visicorp will no doubt be a leader in this area, if its product lives up to the recent

demonstations made at shows around the country. With its applications packages of Visicalc, Visidex, Visifile, Visiplan, Visiword (the new word processor), and a relational database manager (in development) integrated under Visi On (acting as the window manager), Visicorp appears to have the first low-cost system that will work on many different machines. Visihost, similar to the BIOS section of CP/M, acts as the interface software module to accommodate different hardware configurations. Visicorp is promising versions for the IBM Personal Computer and DEC professional computer initially, with versions expected to follow for other machines, including Unix-based machines.

Visi On will probably not be available until mid-summer. Experts who have seen the limited demonstration are impressed but question whether the actual product can run as fast. Visicorp has released few details about the system, but I believe that on the IBM Personal Computer it will require 512K bytes of memory and a hard disk. Add the cost of the software and mouse from Visicorp, and it is likely that the complete system will cost more than the Apple Lisa. Visicorp is not too concerned about this because it expects that most Visi On systems will be sold to people who already have IBM Personal Computers or DEC machines and are looking to upgrade their systems.

The Lisa, with its higher-resolution graphics and ability to run concurrent applications programs (Visi On supports only single tasks) and its integrated local-area networking facilities (still a question mark with Visi On), will most likely to appeal to businesses looking to purchase a complete system. However, there are still a lot of unknowns at this point, and it will be most interesting to watch how the competition develops.

The Apple Lisa will be sold with six integrated software packages for just under $10,000. Apple furnished prototype machines to Unisoft, Microsoft, and Digital Research, and the companies have already demonstrated Uniplus, Xenix, and CP/M-68K operating systems on the Lisa (with limited graphics). Apple has demonstrated Smalltalk on the Lisa and plans to release it. The company appears to be following the same policy that made the Apple II a huge success. Apple has made detailed information available to independent software houses and will soon offer a toolkit for the Lisa the way it did for the Apple II.

Lotus Development Corporation, with its 1-2-3 package, which integrates a sophisticated spreadsheet with many advanced features, a database manager, and a word processor, will also be a contender in this arena. And Microsoft, with its new version of MS-DOS, Multiplan (one of the most powerful spreadsheets currently available), the Multi-Tools family, and Xenix compatibility, is also expected to be a strong competitor in this area.

Digital Research, which recently added a SIGGRAPH-standard compatible graphics interface to CP/M and improvements such as concurrency and memory- and disk-management features, still relies on independent vendors for applications software; this has resulted in a distinct lack of integrated software under CP/M. (SIGGRAPH is the Association for Computing Machinery's Special Interest Group on Graphics.) Use of the standard will make it easier for outside software vendors to integrate their software; still, Digital Research seems to be missing the integrated-software boat.

It's still questionable whether the $10,000-and-up prices for these integrated systems will limit their acceptance in the marketplace; after all, Xerox tried to pioneer this area two years ago with the Star (at a $16,000 base price) and was not successful. Will users be willing to pay $10,000 to $12,000 for these features? It may be that Apple is really counting on its Mackintosh system, due for introduction later this year, that will have some of the Lisa features and a lower price.

LAN Standard Endorsed: Thirteen firms have endorsed the LAN (local-area network) standard currently being worked on by an IEEE (Institute of Electrical and Electronics Engineers) committee. Called the IEEE P802.3 draft standard for CSMA/CD (Carrier Sense, Multiple Access with Collision Detection), it integrates the Ethernet and ECMA (European Computer Manufacturers Association) specifications. The companies endorsing the proposed standard include Bridge Communications, Data General, DEC, Fujitsu America, Hewlett-Packard, Intel, Interlan, National Semiconductor, Siemens, Tektronix, 3Com, Ungermann-Bass, and Xerox.

Prices Continue Dropping: Toys 'R' Us, a large chain of toy stores, is opening computer sections that in some cases will occupy a quarter of a store's floor space. This is just a sign of the major changes occurring in the home computer marketplace.

The competition in the mass-merchandised personal computer market is getting fierce. I have already seen the Timex Sinclair 1000 advertised for $66 minus a $15 rebate (list price is $79) and the Commodore VIC-20 for under $135. Texas Instruments (TI), via its rebate program, has brought the model 99/4A down to under $150, and now Atari has introduced a rebate for the model 400 that brings its price down to under $200. The more powerful Atari 800 is now retailing for under $500.

Mattel, Magnavox, Emerson, and Video Technology are also entering the fray in the under-$200 market. Emerson expects to do this by offering a keyboard attachment for the Atari 2600 video-game unit; however, Atari has announced its own keyboard for that unit. Mattel and Coleco are doing likewise for their game systems. Atari expects to double the number of stores carrying its units to 15,000 by the end of this year and to spend 50 percent more on advertising, with most going into television spots. Commodore has also dropped the price on its Model 64 and offered it for sale via mass merchandisers. The under-$100 market, now currently dominated by Timex Computer Corporation, will soon see entries from Commodore, Sharp, and Casio.

Personal Robotics: Numbers of home experimenters have built personal robots during the last few years. Tod Loufbourrow, for example, wrote a book five years ago describing the construction details for his robot, which had a primitive sensory system and could respond to a limited set of commands in its master's voice. Over the last three years, several companies have introduced robotic arms controlled by personal computers; however, these are essentially expensive teaching tools, some costing as much as $5000.

The introduction of the HERO-1 from Heath will have a profound impact on personal robotics (see "Heath's HERO-1 Robot" by Steven Leininger, January 1983 BYTE, page 86). Although still intended as an educational product, its $1500 price (in kit form) puts it well within the range of many schools and home experimenters. Thus we can expect to see homebrewed improvements, added features, and peripherals for this and similar robotic kits; perhaps newer kits will be available at even lower cost. For example, Nolan Bushnell (founder

of Atari) has formed a new company called Androbot, in Sunnyvale, California, that has announced two home robots. One is expected to sell for under $1000 and use a radio link to a home computer; the second will be a $2500 robot with onboard brains using three 8088 microprocessors and 3 megabytes of memory. The Robot Shack, of El Toro, California, is offering its 7-inch-high Droid for $99 and a 38-inch-high PR-1 for $499; both offer remote-controlled motion, speech recognition, and speech output.

We are at a point in personal robotics comparable to the situation in the early 1970s when home experimenters were building primitive computers with the Intel 8008 microprocessor. It took only another three to four years for these systems to move from basements to computer stores; by the end of the decade, computers were being mass merchandised. I therefore predict that by the end of this decade we will see personal robots mass merchandised just as personal computers are today.

Japan Launches New Software Development Effort: Japan is attempting to enter the software business by making a long-term commitment to supporting software houses. Following the same technique used in other fields, the Japanese government and industry are cooperating to provide the stimulus. Japan's Ministry of International Trade and Industry has launched a five-year project to create new operating-system software, software-development technology, and languages. Now in its third year, the project has $192 million in funding, half coming from government and half from industry (participants include Nippon Electric Company [NEC], Hitachi, Fujitsu, Matsushita, Toshiba, Mitsubishi Electric, Oki, and Sharp). Of this sum, $10.6 million was funneled to 2000 independent software houses.

Further, the Japanese government gave industry a 40 percent tax deferral on software revenues for the first four years of any developed program's life. Some of the larger companies, such as Hitachi, spun off their software operations into independent subsidiaries to make them less bureaucratic. Although most experts feel that Japan is still about 10 years behind the U.S. in software development, in some areas the Japanese have made significant strides. Japan has already developed banking and airline-reservation software considered equal to that used in the U.S. Further, its video games and robotics software are considered first rate.

U.S. Firms Establish Foreign Software Operations: More and more U.S. computer makers are setting up software development operations outside the U.S., most notably in England and Europe. For example, DEC, Hewlett-Packard, Honeywell, Prime, Perkin-Elmer, and Modcomp all have established software operations near London. This has led to the creation of a large number of independent software shops. Packages for software development, games, database management, videotex, electronic mail, transaction processing, and packet-switched communications have already appeared from these operations. Increasing numbers of these software packages are being sold in this country. Most notable are packages for microcomputers, such as The Last One, Pearl, and CIS COBOL, all developed in England by independent software shops.

Public-Domain Software: It never ceases to amaze me how few personal computer users are aware of the existence of large libraries of public-domain software. That is, software that has not been copyrighted and thus can be legitimately copied. There are dozens of

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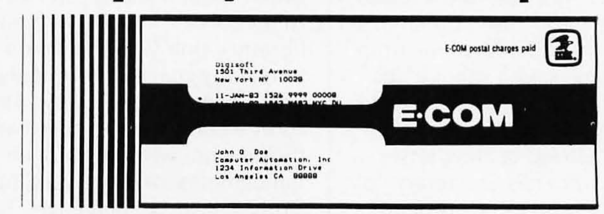
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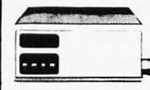
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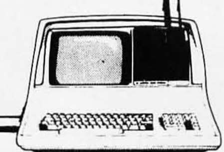


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these libraries in existence, run mainly by computer clubs. Typically, these clubs gather software donations from their members or from exchanges with other clubs.

For example, the club that I belong to (the Amateur Computer Group of New Jersey—ACG-NJ) has a library of CP/M-compatible programs that fills over 100 disks. Each disk is packed with about 240K bytes of programs; in other words, there are over 24 megabytes of free software in the library. The club asks members to contribute $1 each time they copy a "volume" (disk); if members wish, they may telephone a computer system maintained by the club that contains much of this software and is capable of downloading files. The club will furnish a printed catalog of its software offerings for just $2 (request it from SIG/M, POB 97, Iselin, NJ 09930).

The ACG-NJ SIG/M and the CPMUG (CP/M User's Group, 1651 Third Ave, New York, NY 10028) libraries are without doubt the largest such organizations in existence. For example, in their libraries, one will find 13 different language interpreters and compilers, many in source-code form so that those who wish to add enhancements or just want to study how a language is created can do so. Also available are BASIC (six versions), ALGOL, FOCAL, RATFOR (Relational FORTRAN), Pascal, STOIC (a FORTH-like language), PISTOL (Portably Implemented Stack Oriented Language), ACTOR, SAM (both string-processing languages) PILOT (Programmed Inquiry and Learning), PIDGIN, and TINCMP.

East Bloc Personal Computing: I have recently received some amateur-computer club newsletters from Hungary and Yugoslavia, two European socialist countries. From reading these newsletters it would appear that personal computing is starting to take hold in these countries in much the same way as it started here in the U.S. These hobbyists appear to be about four to six years behind those in the U.S. Surprisingly, much of their equipment is either U.S.-made or copied from U.S. equipment. For example, the TRS-80 Model I and copies of it are popular.

S-100 Update: In the March 1983 BYTELINES (page 492), I estimated that there were 150 manufacturers of S-100 products making over 500 plug-in boards. A recent survey conducted by *Microsystems* magazine has turned up the fact that there are over 200 manufacturers making over 1000 different S-100 products. Thus, although the S-100 marketplace is very diverse, when taken as a single group, it represents the largest segment of the the current microcomputer-peripherals market.

Z800 Update: In my February 1983 column (page 430) I reported that Zilog expected to start offering samples of its new Z800 in the spring, with production expected in the fall. I regret to report that I was wrong; the firm expects to start supplying samples in the fall with production expected early next year.

Random News Bits: The deregulation of the Bell System has allowed Western Electric, the manufacturing arm of AT & T, to go into the business of manufacturing components. Western Electric has hired salesmen to go out on the road to sell components that were previously available only within the Bell System. This will include a new 256K-bit semiconductor memory, bubble memory, and microprocessor parts. . . . Xerox has disclosed that its Office Products division, which sells the 820 desktop computer and the Star workstation, had a significant loss last year. . . . IBM has finally begun distributing the Personal Computer outside the U.S. The firm has also introduced an upgraded model of the Personal Computer, the XT (see page 520 for more on the new machine).

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

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BYTE's Bits

Call for Papers on Industrial Electronics

Papers are being solicited for the International Conference on Industrial Electronics (IECON '83) to be held from November 7–11 at the Hyatt Regency Hotel in San Francisco. Send papers to R. C. Born, Eaton Corp.: Cutler Hammer, 4201 North 27th St., Milwaukee, WI 53216, (414) 449-7474.

Comments on BASIC Standard Needed by July

The public comment period for the proposed American National Standard for BASIC is now in effect. Copies of the dráft may be obtained by writing to:

X3 Secretariat
Computer and Business Equipment Manufacturers Association
311 First St. NW
Washington, DC 20001

Request document X3J2/82-17, called "Draft Proposed American National Standard for BASIC." The price is $20 (check or money order). Comments should be sent to the same address by mid-July.■

Event Queue

May 1983

May
Information Processing Seminars, various sites throughout the U.S. Datapro Research Corporation offers more than 35 seminars about information processing. Among the titles are "User Friendly Information Delivery: Approaches to Online Systems Development," "The Personal Computer: Strategies for Managing," and "Productivity in MIS: Defining Measurements and Establishing Programs." These courses can be presented on an in-house basis. For a seminar catalog, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

May-June
Computer Literacy for Lawyers, various sites throughout the U.S. This seminar is intended to introduce attorneys to basic computer concepts and their application to the practice of law. Subjects covered include the specific uses, costs, and benefits of using computers in legal practice. The fee for each participant is $550, which includes reference materials. Group discounts are available. For further information, contact Kathryn Mann, Center for Legal Studies, 1926 Arch St., Philadelphia, PA 19103, (215) 732-6999.

May-June
Computer Showcase Expos, various sites throughout the U.S. This popular show will bring together sellers and individual users of small computer systems. For details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

May-June
Courses from Q.E.D. Information Sciences, various sites throughout the U.S. Some of the courses listed are "Systems Analysis Workshop," "Project Management and Control," and "Data Analysis." Address inquiries to Priscilla Goudreault, Q.E.D. Information Sciences Inc., Q.E.D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

May-June
Data Processing Courses, the Hartford Graduate Center, Hartford, CT. Among the courses being offered are "ANS COBOL Programming Workshop 1" and "CICS/VS Command Level Coding Workshop." These data-processing courses are available for on-site presentation. For details, contact Don Florek, The Hartford Graduate Center, 275 Windsor St., Hartford, CT 06120, (203) 549-3600, ext. 252, 253, or 254.

May-June
Intel Microcomputer Workshops, various sites throughout the U.S. Among the workshops to be held are "Introduction to Microprocessors" and "iAPX 86, 88, 186 Microprocessors." Intel Customer Training courses are available for on-site presentation. For details, contact Intel Corp., Mail Stop SV3-1, 3065 Bowers Ave., Santa Clara, CA 95051.

May-June
Intensive Seminars of Interest to Data Processing Professionals, Boston metropolitan area. Among the two- to five-day seminars offered are "Project Management" and "Systems Design." Registration fees range from $495 to $975. For a seminar bulletin, contact Ms. Ginny Bazarian, Office of Continuing Education, Higgins House, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

May-June
Management Development Programs, Providence, RI, Boston, MA, and Hartford, CT. The Center for Management Development offers seminars on a variety of topics, including communications, industrial relations, and electronic data processing. Many of the Center's programs can be conducted on location for your organization. For complete information, contact The Center for Management Development, Bryant College, Smithfield, RI 02917, (401) 231-1200, ext. 314.

May-June
Microprocessor Seminars, Rochester Institute of Technology, Rochester, NY. Five one-week seminars are offered: "Basic 8085," "Advanced 8085," "Basic 6800," "Advanced 6800," and "Advanced Digital Electronics." Hands-on experience is provided. The fee is $480. Contact Jeanne Berry or Stacy Jordan, Rochester Institute of Technology, Rochester, NY 14627, (716) 475-2915.

May-June
Office Automation: Tee to Green, various sites throughout the U.S. This three-day seminar for administrative and information-systems professionals addresses the complex production issues and opportunities presented by automation of the office workplace. Seminar objectives include developing a productivity program, establishing long-range office systems plans, and developing integrated communications systems. The fee is $385 for members of the Data Processing Management Association Education Foundation (DPMA/EF) or $410 for nonmembers. For registration information, contact DPMA/EF Conferences, D. L. Hiller & Associates, 14536 Island Dr., Sterling Heights, MI 48078, (313) 247-8444.

May-June
Professional Development Seminars, various sites throughout the U.S. Data communications, database management, software and systems, and computer-aided design/manufacturing are some of the areas investigated in seminars offered by the Institute for Advanced Technology. For a detailed catalog, contact the Registrar, Institute for Advanced Technology, Control Data Corp., 6003 Executive Blvd., Rockville, MD 20852, (800) 638-6590; in Maryland, (301) 468-8576.

May-June
Seminars in Simulation, Management, Statistics, and Computer Science, various sites throughout the U.S. "Simulation Modeling for Decision Making," "Database Design," and "Satellite Communications Technology" are some of the topics to be presented. For information, contact the Institute for Professional Education, POB 756, Arlington, VA 22216, (703) 527-8700.

May-July
Courses from Integrated Computer Systems, various sites throughout the U.S. Course titles include "Com-

puter-Aided Design and Manufacturing," "Computer Graphics," "Hands-On Pascal Workshop," "Defining Software Requirements, Specifications, and Tests," and "Computerized Robots." Fees range from $695 to $845. For information, contact Ruth Dordick, Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, or call (213) 450-2060.

May-July
Productivity '83, various sites throughout the U.S. and Canada. This is Hewlett-Packard's hands-on showcase of more than 32 computer products and 17 seminars. It's designed to provide data-processing professionals and novices with answers to problems confronting the industry. For details, call (800) 453-9500.

May-July
Technical Courses from Zilog, Campbell, CA. A wide variety of such courses as "Z80 Assembly Language" and "ZEUS/System 8000 User Course" are offered. Fees range from $175 to $875. For a complete schedule, contact Zilog Inc., Training and Education Department, 1315 Dell Ave., Campbell, CA 95008, (408) 370-8092.

May-August
Courses in C Language and Unix, various sites throughout the U.S. Three 5-day courses are offered by Plum Hall Inc. The "C Programming Workshop," a hands-on course, covers all aspects of the C language for individuals able to program in another language. The "Advanced C Topics Seminar" covers efficiency, portability, readability, debugging, packaging, and interfacing. The "Unix Workshop" is an introductory course that focuses on software development. For further details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

May-December
Courses from the AMA, various sites throughout the U.S. The American Management Associations (AMA) offers an on-going series of seminars in such areas as human resources, information systems, and manufacturing and technology management. In-house development and training seminars can be arranged. For information on AMA membership or seminar particulars, contact the American Management Associations, 135 West 50th St., New York, NY 10020, (212) 586-8100.

May-December
IEEE Conferences and Meetings, various sites around the world. The Institute for Electrical and Electronics Engineers (IEEE) sponsors conferences, meetings, and workshops covering high-technology issues. For details, contact the IEEE Computer Society, Suite 300, 1109 Spring St., Silver Spring, MD 20910, (301) 589-8142.

May 10-11
Selecting a Microcomputer for Scientific and Engineering Applications, Golden, CO. This short course reviews hardware and software technology for potential buyers of microcomputers in relation to specific scientific and engineering applications. The fee is $195. Contact the Space Office, Colorado School of Mines, Golden, CO 80401, (303) 273-3321.

May 10-12
Mini/Micro-Northwest, Portland, OR. Running concurrently with Northcon/83, this show addresses such topics as aerospace electronics, laser applications, and semiconductor technology. Contact Electronic Conventions Inc., Suite 410, 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-6816; in California, (800) 262-4208 or (213) 772-2965.

May 11-15
Computa '83: The Third International Exhibition on Computer and Information Processing Technology, World Trade Centre, Singapore, Republic of Singapore. Information is available from Kallman Associates, 5 Maple Court, Ridgewood, NJ 07450, (201) 652-7070.

May 12-13
The Fourth Annual Computer Law Institute, University of Southern California Law Center, Los Angeles. This year's Institute will present a program on structuring agreements for the distribution of computer products domestically as well as inter-

nationally. Other topics include proprietary rights, antitrust issues, and major system procurements. An optional session on the basics of computer products and technology will be offered. Contact Ami Silverman, USC Law Center, University Park, Los Angeles, CA 90007, (213) 743-2582.

May 13-15
Applefest, Bayside Exposition Center, Boston, MA. This is the third annual Boston Applefest. More than 400 displays of Apple-compatible products will be featured. Complementing the exposition will be seminars, conferences, workshops, and panel discussions. Call or write Northeast Expositions, 826 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

May 14-15
Toronto PET User's Group Conference, George Brown College, Casa Loma campus, Toronto, Ontario, Canada. Speakers, workshops, a trader's corner for used equipment, and exhibits of hardware, software, and accessories highlight this event. Contact Chris Bennett, TPUG Corresponding Secretary, 381 Lawrence Ave. W, Toronto, Ontario M5M 1B9, Canada, (416) 782-9252.

May 15-20
Problem-Solving Leadership, San Francisco, CA. This workshop, designed to help managers and technical leaders enhance their problem-solving effectiveness, is sponsored by the Data Processing Management Association Education Foundation (DPMA/EF). Further information is available from Judy Cook, Weinberg & Weinberg, R R #2, Lincoln, NE 68505, (402) 781-2542.

May 16-18
Computer Graphics for Engineering/Drafting Practice, University of Texas, Austin. This course will stress developing the ability to prescribe and implement computer graphics equipment for specific engineering applications. A two-day hands-on workshop follows the course. Contact the College of Engineering, University of Texas, Austin, TX 78712, (512) 471-3396.

May 16-18
Mini-Conferences and Professional Growth Seminars, Loews Anatole, Dallas, TX. A special feature of this event will be the introduction of the data-entry certification program. Among the topics to be addressed are motivation, training, and interviewing. Contact Marilyn S. Bodek, Data Entry Management Association, POB 3231, Stamford, CT 06905, (203) 322-1166.

May 16-19
National Computer Conference, Anaheim and Disneyland Hotel Convention Centers, Anaheim, CA. This show features exhibits of computer products and services, technical sessions, seminars, and formal addresses. For complete information, contact the American Federation of Information Processing Societies Inc., 1815 North Lynn St., Arlington, VA 22209, (703) 558-3624.

May 16-19
Patent Your Software for Profit, Anaheim, CA. This seminar, which runs concurrently with the National Computer Conference, will explore software patent examples and offer advice on patenting and licensing software. Patent reference materials will be provided. Full details are available from Delbert L. Keenon, Automation Inc., 3410 Mona Lee, Houston, TX 77080, (713) 462-4151.

May 16-20
Auditing in the Contemporary Computer Environment, New York, NY. This course is designed for internal auditors and financial and data-processing professionals. Participants will learn a comprehensive audit approach for computer-based systems, including how to evaluate controls and how to design a program of tests using questionnaires, checklists, software tools, and flowcharts. Contact Marge Umlor, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

May 16-20
Auditing Integrity Controls in the Contemporary Com-

puter Environment, Washington, DC. This program is designed to provide an overview of the computer environment, its controls, and its interrelationships. It combines theoretical and practical approaches for electronic data-processing auditing, with an emphasis on integrity controls and related operational concerns. Further details are available from Marge Umlor, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

May 16-20
Session '83, Skyline Hotel, Ottawa, Ontario, Canada. The theme of this annual conference of the Canadian Information Processing Society (CIPS) is "Converging Technologies." Des Cunningham, president of Gandalf Technologies, will be the keynote speaker. For further details, write Session '83, POB 2577, Station D, Ottawa, Ontario K1P 5W7, Canada, or call Ron Elliott, (613) 234-4333.

May 17-20
Technology/Invention New Product Expo, Expo Mart, Monroeville, PA. This show will feature everything from diesel fuel-injection systems to spring-loaded fly swatters. Further details can be obtained from Gary F. Brown, Technology/Inpex, Suite 400, 701 Smithfield St., Pittsburgh, PA 15222, (412) 288-1344.

May 18-19
Third Annual Computer Conference, Iona College, New Rochelle, NY. This conference is devoted to the newest developments in the use of microcomputers, with an emphasis on education and business. Seminars, workshops, formal papers, and product exhibits will be featured. The fee is $35 per day. Contact Mr. McCallion, Iona College, New Rochelle, NY 10801, (914) 636-2100.

May 18-20
The Fifth National Conference of the Cognitive Science Society, University of Rochester, Rochester, NY. This conference will consist of lectures, panels, commentaries, and papers. Contact the Cognitive Science Conference, Dewey Hall, University of Rochester, Rochester, NY 14627, (716) 275-5402.

May 18-20
Man Machine Interface, Palo Alto, CA. For full details, contact the Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; on the West Coast, call (213) 824-9545.

May 18-20
Mipro-83: The Sixth Microprocessors/Microcomputers Course/Conference, Congress Center, Hotel Adriatic, Opatija, Yugoslavia. The theme for this conference is "Advanced Microcomputer Application Techniques and New Trends." It is geared toward hardware and software specialists and managers involved with the development, production, and management of microcomputer-based systems. For details, contact Mr. P. Dragojlović, Mipro Secretariat, Trg P. Togliatti 4, 51000 Rijeka, Yugoslavia.

May 19-20
Computers in Construction, Denver, CO. This seminar is designed to assist construction contractors and construction management firms in acquiring computer systems. The registration fee is $395. For further information, contact CIP Information Services Inc., 1105-F Spring St., Silver Spring, MD 20910, (301) 589-7933.

May 19-22
Maryland Computer Show and Office Equipment Exposition, Convention Center, Baltimore, MD. Address inquiries to Dee Harris, Computer Expositions Inc., POB 3315, Annapolis, MD 21403, (800) 368-2066; in Maryland, (301) 263-8044.

May 20-22
Computers and Personal Values: Sharing from Experience, Sign of the Dove, Temple, NH. This workshop offers individuals in the computer community the opportunity to examine personal, ethical, or moral questions associated with their work and with the impact of computers on society. The format includes small and large discussion groups and invited speakers. The cost is $150.

For more information, contact Arthur Fink, Prince St., Box 614, Wilton, NH 03086, (603) 654-6518.

May 21

The Sixth Annual Spring Microcomputer Show & Tell Conference, University of Oklahoma, Norman. This conference is designed to let computer enthusiasts share ideas and information. Speakers will demonstrate their devices and field questions from the audience in six show and tell periods. Also featured is an on-the-spot programming contest. For additional information, contact Dr. Richard V. Andree, Mathematics Department, University of Oklahoma, Norman, OK 73019, (405) 325-3410.

May 22-25

The Eighteenth Annual Meeting and Exhibit Program of the AAMI, Loews Anatole, Dallas, TX. Topics on the docket include anesthesia instrumentation and technology, computer applications, personnel management, and technology transfer. Roundtable discussions, tutorials, and an exhibit program will be featured. For details, contact the Association for the Advancement of Medical Instrumentation, Suite 602, 1901 North Fort Meyer Dr., Arlington, VA 22209, (703) 525-4890.

May 22-26

Annual Industrial Engineering Conference and Exposition, Galt House Hotel and Commonwealth Conference Center, Louisville, KY. "Racing for Productivity" is the theme of this event sponsored by the Institute of Industrial Engineers (IIE). More than 130 educational sessions will address a broad range of issues; computer hardware and software, material handling equipment and systems, and process-control equipment will be shown. Preconference seminars will be held from May 19 to 22. Registration fees are $240 for IIE members and $290 for nonmembers. Contact the Registrar, Conference Department, IIE, 25 Technology Park/Atlanta, Norcross, GA 30092, (404) 449-0460.

May 23-25

The Technology of Personnel Conference, Grand Hyatt Hotel, New York, NY. Sponsored by the Association of Human Resource Systems Professionals (HRSP), this conference will offer a range of presentations and workshops covering human resource technology and the social and psychological implications of this technology on workers and organizations. Contact HRSP Inc., Mills Square Tower, 100 South Ellsworth Ave., San Mateo, CA 94401, (415) 593-4461.

May 23-27

Auditing Integrity Controls in the Contemporary Computer Environment, New York, NY. For details, see May 16-20.

May 24-26

Microprocessor Background for Management Personnel, Palo Alto, CA. The fee for this course is $565, which includes text and program materials. Contact Continuing Education in Engineering, Department 532N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

May 24-27

Interact, Hilton Hotel, Denver, CO. This convention is for members of the international users group of Management Science America's (MSA's) Human Resource System. More than 1200 payroll, personnel, and data-processing professionals are expected to attend. Contact MSA Inc., Suite 1300, 3445 Peachtree Rd. NE, Atlanta, GA 30326.

May 31-June 2

The Second Canadian Computer-Aided Design/Computer-Aided Manufacturing and Robotics Exposition and Conference, International Centre of Commerce, Toronto, Ontario, Canada. Leading international companies will demonstrate industrial robots, automatic assembly equipment, optical scanners, and numerically controlled machine tools. Technical papers will focus on such topics as robot-vision systems and design analysis. For information, contact Hugh F. Macgregor & Associates, 662 Queen St. W, Toronto, Ontario M6J 1E5, Canada, (416) 363-2201.

May 31-June 4

The Twelfth Annual MUMPS Users' Group Meeting, Hilton Hotel, San Francisco, CA. Introductory and advanced tutorials, workshops, roundtable discussions, site visits, and hardware, software, and systems demonstrations and exhibits all relating to the MUMPS computer language will be offered. Registration information is available from Charles White, Professional Associates, 2012 Big Bend Blvd., St. Louis, MO 63117.

June 1983

June

Continuing Engineering Education Courses, George Washington University, Washington, DC. Among the courses available are "Database and File Management for Microcomputers," "Computer Communications Systems and Networks," and "A Phased Approach to Software Conversion." Course fees range from $625 to $855. For information, contact Douglas Green, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8512.

June 1-4

The First Annual Sunbelt Educational Computing Conference, Texas Tech University, Lubbock. The theme for this conference is "Practical Applications and Current Issues in Educational Computing." For details, write to Dr. Cleborne D. Maddux, College of Education, Texas Tech University, POB 4560, Lubbock, TX 79409.

June 2-4

Personal Computer Interfacing and Scientific Instrument Automation, Charlotte, NC. This workshop provides each participant with hands-on experience in wiring and testing interfaces. The fee is $395. Call or write Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848.

June 5-8

Consumer Electronics Show (CES), McCormick Place, Chicago, IL. This show is sponsored by the Electronic Industries Association (EIA). For information on this popular event, contact the CES Shows Office, Suite 1607, Two Illinois Center, 233 North Michigan Ave., Chicago, IL 60601, (312) 861-1040.

June 5-8

Mini-Conferences and Professional Growth Seminars, Registry Resort Hotel, Scottsdale, AZ. For details, see May 16-18.

June 5-9

The Twelfth Annual International Software AG Users' Conference, Fairmont and Royal Sonesta Hotels, New Orleans, LA. This conference will feature speakers, presen-

Event Queue

tations, workshops, and tutorials. For details, contact Paula J. Brooks, Software AG of North America Inc., 11800 Sunrise Valley Dr., Reston, VA 22091, (703) 860-5050, ext. 578.

June 6

New Trends in Rapid IC Processing Techniques: Lasers, Electron Beams, and Incoherent Sources, Hyatt Palo Alto Hotel, Palo Alto, CA. The fee for this engineering course is $195. Registration details are available from Continuing Education in Engineering, Department 564N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

June 6-8

The Fifth Annual National Educational Computing Conference–NECC 83, Towson State University, Baltimore, MD. This conference provides a broad forum for discussion among individuals at all levels who share an interest in educational computing. Papers will be presented; tutorials will be held; and demonstrations and exhibits will emphasize computer uses in instruction. For registration forms, contact Doris K. Lidtke, NECC 83, Department of Mathematics and Computer Science, Towson State University, Baltimore, MD 21204.

June 6-8

The Sixth International Conference on Computers and the Humanities–ICCH/83, North Carolina State University, Raleigh, NC. This conference serves as a forum for the exchange of ideas on the use of computers in all areas of the humanities. Features include formal sessions, discussion groups, tutorials, workshops, and exhibits. For details, write to Dr. Sarah K. Burton, Department of English, POB 5308, North Carolina State University, Raleigh, NC 27650.

June 7

Materials Characterization for Ion Implantation, Hyatt Palo Alto Hotel, Palo Alto, CA. The fee for this engineering course is $195. Registration details are available from Continuing Education in Engineering, Department 564N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

June 7-8

International Conference on the Use of Micros in Fluid Engineering, Tara Hotel, London, England. All aspects of the use of microcomputers and microprocessors in fluid engineering will be covered. Subjects of interest include developing software for fluid-engineering design, rapid response controllers, and data-acquisition and analysis on-site. Full details are available from the Organizing Secretary, Micros in Fluid Engineering, BHRA Fluid Engineering, Cranfield, Bedford MK43 0AJ, England; tel: (0234) 750422; Telex: 825059.

June 7-9

International Computer Show, Velodrome, Olympic site, Montreal, Quebec, Canada. This trade show is designed for businesses wishing to identify or compare computers and equipment for automating the office or for industrial activities. For details, contact Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

June 7-9

Maptek Europe 1983: Annual Strategy Conference, Hotel Excelsior, Venice, Italy. This meeting will provide detailed market forecasts and strategic

recommendations for computer systems, network information services, communications and teleconferencing, office systems, and departmental integration. Contact Robert B. King, Quantum Science Corp., 1114 Avenue of the Americas, New York, NY 10036, (212) 997-0070. In Europe, contact Constantine E. Adraktas, Quantum Science Corp., 16 Charles II St., London SW1Y 4QU, England; tel: (01) 839-5347.

June 7-11

The Third Rochester FORTH Applications Conference, Laboratory for Laser Energetics, University of Rochester, NY. This conference is sponsored by the Institute for Applied FORTH Research Inc. Speakers will cover robotics and FORTH in a special one-day session. For complete details, contact Diane Ranocchia, Institute for Applied FORTH Research Inc., 70 Elmwood Ave., Rochester, NY 14611, (716) 235-0168.

June 8-10

The International Conference on Consumer Electronics-ICCE, Ramada the O'Hare Inn, Des Plaines, IL. Technical papers and panel discussions will address such issues as personal computing, low-cost printers, and computer-aided design/manufacturing techniques. Products will be displayed. This conference is sponsored by the Consumer Electronics Society of the Institute of Electrical and Electronics Engineers. Contact ICCE, POB 149, Bloomingdale, IL 60108.

June 9-11

Microcomputers in Education, Watertown, CT. This hands-on workshop is designed for teachers and administrators at all levels. Topics include microcomputers in science and mathematics instruction, Logo, Pascal, machine language, and microcomputers and the education of students with special needs. Contact Ms. Sharon Woodruff, Technical Education Research Centers, 8 Eliot St., Cambridge, MA 02138, (617) 547-3890.

June 11-12

NJ-NY-CT Microcomputer Show and Flea Market, Meadowlands Hilton Hotel, New Jersey Sports Complex, East Rutherford, NJ. More than 75 commercial exhibitors and 200 flea-market booths will feature hardware, software, magazines, and accessories for all popular computing systems ranging from Apple to Zenith. Registration is $5 for adults and $2 for children under 12. Contact Kengore Corp., POB 13, Franklin Park, NJ 08823, (201) 297-2526.

June 13-15

Analysis and Design-Oriented Techniques, Los Angeles, CA. For details on this power-electronics course, contact Teslaco, Suite 6, 490 South Rosemead Blvd., Pasadena, CA 91107, (213) 795-1699.

June 13-15

Systematic Software Maintenance, Chicago, IL. Topics to be addressed include structured methodologies, solutions for effective testing, resource allocation, and status determination. Full details are available from Eduteach Inc., Suite 907, 162 North State St., Chicago, IL 60601, (312) 641-1370.

June 14-16

Introduction to Microprocessors, University of Texas, Austin. This course will stress basic concepts with hands-on experience. Participants will write and run simple programs on a Z80-based Micro-Professor training system. Contact the College of Engi-

neering, University of Texas, Austin, TX 78712, (512) 471-3396.

June 14-16
Ohmcon/83, High-Technology Electronics Exhibition and Convention, Cobo Hall, Detroit, MI. For details, contact Electronic Conventions Inc., 999 North Sepulveda Blvd., El Segundo, CA 90245, (800) 421-6816; in California, (213) 772-2965.

June 14-16
Technology Opportunity Conference, Washington, DC. This conference will focus on the convergence of optical-storage, videodisc, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1133.

June 14-18
Tectronica, Earls Court Exhibition Centre, London, England. This exhibition on laboratory technology aims to show the latest in instrumentation, equipment, and services for life and physical sciences. For details, contact Good Relations Ltd., 15 Adeline Place, London WC1B 3AJ, England; tel: (01) 636-6561; Telex: 265903.

June 15-17
Basics of Power Electronics, Los Angeles, CA. For information on this course, contact Teslaco, Suite 6, 490 South Rosemead Blvd., Pasadena, CA 91107, (213) 795-1699.

June 15-17
The Twenty-first Annual Meeting of the Association for Computational Linguistics, Massachusetts Institute of Technology, Cambridge, MA. Papers to be presented will address syntax, the representation of knowledge, machine and machine-aided translation, and other linguistically and computationally significant topics. Information is available from Don Walker, Artificial Intelligence Center, SRI International EJ278, Menlo Park, CA 94025, (415) 859-3071.

June 16-17
Clinical Laboratory Computers: Symposium 1983, Towsley Center for Continuing Medical Education, Ann Arbor, MI. Course credit will be offered. Contact the Office of Continuing Medical Education, Towsley Center Box 057, University of Michigan Medical School, Ann Arbor, MI 48109, (313) 763-1400.

June 16-18
Personal Computer Interfacing and Scientific Instrument Automation, Reston, VA. For details, see June 2-4.

June 17-19
PC '83/West, Brooks Hall/Civic Center Complex, San Francisco, CA. This show will bring together users, developers, distributors, and retailers of products that are compatible with the IBM Personal Computer. Seminars, workshops, demonstrations, and a conference program will aim to educate users on product features and capabilities. Further conference information is available from Northeast Expositions, 826 Boylston St., Chestnut Hill,

MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

June 19-23
Conference on Computer Vision and Pattern Recognition–CVPR '83, Crystal City Hyatt, Arlington, VA. This program, formerly known as the Pattern Recognition and Image Processing Conference, provides a forum for the presentation of papers on vision, pattern recognition, and image processing. For full details, write to CVPR '83, POB 639, Silver Spring, MD 20901.

June 19-24
Problem Solving Leadership, Washington, DC. For details, see May 15-20.

June 20-July 15
Computers in Education '83—CE '83, Rutgers State University, New Brunswick, NJ. The theme of this conference is "Necessary Direction for Computer Education: Navigational Aids for the 80s." The focus will be on the impact of microcomputers on elementary, secondary, and college-level education. Conference highlights include presentations, special-interest sessions, a software exchange, and a film festival.

Running concurrently with CE '83, the Summer Institute for educators offers 40 short courses, ranging in length from one to twelve days. Topics include "The Turtle is the Teacher: An Introduction to Logo," "Using Computers in the Elementary School," and "Algorithm Design." Courses are $95 per day. Conference registration is $145. For more information, contact Dr. Mitchell E. Batoff, Director CE '83, Institute for Professional Development, Suite D, 245 Nassau St., Princeton, NJ 08540, (609) 924-8333.

June 23
The Twenty-second Annual Technical Symposium of the Washington DC Chapter of the Association for Computing Machinery, National Bureau of Standards, Gaithersburg, MD. The theme for this event is "Microcomputer Systems: Tools or Toys?" Topics of interest include systems software, human factors, and office systems. For further details, contact Howard Weeks Associates, 15201 Shady Grove Rd., Rockville, MD 20850.

June 27-30
The World of CAD/CAM, Marriott Resort, Newport Beach, CA. This seminar provides an overview of how manufacturing will change as the automated factory becomes a reality. It will consist of four one-day presentations in computer-aided engineering, design, manufacturing, and computer-integrated manufacturing. For a brochure, write or call the Center for Manufacturing Technology, 4170 Crossgate Dr., Cincinnati, OH 45236, (513) 791-8801.

June 27-July 1
Auditing Integrity Controls in the Contemporary Computer Environment, San Diego, CA. For details, see May 16-20.

June 28-30
National Educational Computer Conference, New York Statler Hotel, New York, NY. The theme of this conference is "Higher Instructional Techniques in Education." Seminars, exhibits, hands-on demonstrations, and workshops will highlight this event. Additional information is available from the National Educational Computer Library, POB 293, New Milford, CT 06776, (203) 354-7760.

June 29-July 1
Microcomputers, Electronic Toys, and Genius Machines in Early Childhood Education, Teachers College, Columbia University, New York, NY. This conference will examine the effect of the growing use of the new technology on the entertainment and education of children. Events will include panel discussions, workshops, a computer fair, and a film festival. Participants can attend on a noncredit basis for $125 or for graduate credit at $240 per point. For further information, contact the Program in Early Childhood Education, Box 9, Teachers College, Columbia University, New York, NY 10027, (212) 678-3971.

June 29-July 1
Tertiary Education for the Age of Communications, Royal Melbourne Institute of Technology, Melbourne, Australia. Formal presentations will focus on the educational implications of new technologies as they reflect both on the needs of industry and the requirements of curriculum development. Areas of interest include telecommunications, engineering, and computer and information sciences. For details, contact the International Conference on Communications, Royal Melbourne Institute of Technology, G.P.O. Box 2476V, Melbourne, Victoria 3001, Australia; tel: 3452822; Telex: AA36406.

July 1983

July
Continuing Engineering Education Courses, George Washington University, Washington, DC. Among the courses offered are "An Applications-Oriented Approach to to Artificial Intelligence," "Reliability of Computer Software and Computing Networks," and "Computer Memory Systems." Fees range from $625 to $855. Contact Douglas Green, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-8512.

July-October
Repair of Microcomputer-based Equipment, various sites throughout the U.S. and Canada. This seminar describes general servicing practices that are applied to the subsystems of any microprocessor family. This lecture/laboratory sequence is intended for field-service personnel, engineers, and technical writers. For details, contact the Registrar, Testek Consultants Inc., 1000 North Patton St., Arlington Heights, IL 60004, (312) 577-2134.

July 5-7
Technology Opportunity Conference, London, England. For details, see June 14-16.

July 8-10
Computerfest '83: The Eighth Annual Midwest Affiliation of Computer Clubs Computerfest, Harbourfront, Toronto, Ontario, Canada. Talks, exhibits, and sessions on computers and children will be held. Carl Helmers, editor of *Robotics Age* magazine, is the featured speaker. Further information is available from the Toronto Region Association of Computer Enthusiasts, POB 6922, Toronto, Ontario M5W 1X6, Canada.

July 10-11
The Role of Microcomputers in Music Education, Triton College, River Grove, IL. Seminars, workshops, demonstrations, and manufacturer displays will highlight this event. Topics of interest include ear training, improvisation, computer basics for the teacher, choosing the right computer, and using computers in music for the handicapped. The fee is $25 a day; $40 for both days. Contact Michael Ferrelli, Triton College, 2000 Fifth Ave., River Grove, IL 60171.

July 11-13
The 1983 Summer Computer Simulation Conference, Hyatt Regency, Vancouver, British Columbia, Canada. Full details are available from the Society for Computer Simulation, POB 2228, La Jolla, CA 92038, (714) 459-3888.

July 11-15
Technology Opportunity Conference, Los Angeles, CA. For details, see June 14-16.

July 12-14
Audio-Visual America, Hyatt Regency Hotel, Chicago, IL. The second annual Audio-Visual America will feature hardware and software exhibits, screenings of shows, and approximately 60 workshops on planning, production, and management. For more information, contact A-V America, IF Associates, 3150 Spring St., Fairfax, VA 22031, (703) 273-8272.

July 14-16
Personal Computer Interfacing and Scientific Instrument Automation, Charleston, SC. For details, see June 2-4.

July 18-28
Microcomputer-based Instrumentation for Schools, Middletown, OH. This workshop is designed for secondary school and college science and mathematics teachers. Participants will learn how to construct and use simple, low-cost analog-to-digital (A/D) and digital-to-analog (D/A) converters for monitoring and controlling physical phenomena in the classroom and laboratory. Contact Bill Rouse, 301E McGuffey Hall, Miami University, Oxford, OH 45056, (513) 529-2141.

July 20-21
Token-based Local Networks, Washington, DC. This program is the second of four parts in the Architecture Technology Corporation's 1983 Forum Series. The series will bring together manufacturers and users of local network schemes to exchange information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395 per person. For details, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

July 25-28
The World of CAD/CAM, Dunfey's Resort, Hyannis, MA. For details, see June 27-30.

July 25-29
Robot Manipulators, Computer Vision, and Automated Assembly, Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA. The emphasis of this short course will be on developing strategies for the solution of problems that will arise in advanced automation: sensing, spatial reasoning, and manipulation. The use of current industrial robots and binary vision systems will be covered. For details, contact the Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139.

July 25-29
SIGGRAPH '83, Detroit, MI. This is the tenth annual conference on computer graphics and interactive techniques sponsored by the Special-Interest Group on Computer Graphics of the Association for Computing Machinery (SIGGRAPH ACM). This show features tutorials, films and video tapes, exhibits of computing equipment, and a formal technical program. For full details, contact the SIGGRAPH '83 Conference Office, 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

Software Received

Apple

Bolo, an arcade-type game. You must maneuver your tank through the maze to avoid or destroy enemy tank bases. This game features nine levels of play and five maze densities. For the Apple II; floppy disk, $34.95. Synergistic Software, Suite 201, 830 North Riverside Dr., Renton, WA 98055.

Graphical Analysis. With this graphics-utility program, you can plot graphs based on numerical data in high-resolution graphics. This program is designed to be especially useful for science classes. For the Apple II; floppy disk, $24.95. Vernier Software, 2920 Southwest 89th St., Portland, OR 97225.

Killer T-Cell, an educational-maze game based on biomedical discoveries in cancer research. You control the movements of a T-lymphocyte, a type of white blood cell that destroys cancer cells. All proceeds will fund cancer research at the University of Texas System Cancer Center. For the Apple II; floppy disk, $20. Killer T-Cell, M. D. Anderson Hospital and Tumor Institute, Texas Medical Center, Box 6, 6723 Bertner Ave., Houston, TX 77030.

LIMITS Programs for Calculus Students, an introductory calculus course that covers the fundamentals of the derivative and integral with graphics, drills, and explanations. For the Apple II Plus; floppy disk, $65. Dale T. Hoffman, Division of Science and Mathematics, College of the Virgin Islands, St. Thomas, U.S. Virgin Islands 00801.

Math I, a tutorial program that covers basic mathematical skills up to simple algebra for grades 1 through 8. For the Apple II Plus; floppy disk, $38. Personal Computer Art, 1007 Far Hills Dr., East Peoria, IL 61611.

Nutritionist. Using interactive graphics, this diet-analysis program helps you develop nutritionally balanced meals and diets for both personal and professional uses. For the Apple II; floppy disk, $145. N-Squared Computing, 5318 Forest Ridge Rd., Silverton, OR 97381.

Precision Timer. Using auxiliary equipment, this utility program turns the computer into a flexible laboratory timer. Save timing data on disk and analyze it later. For the Apple II; floppy disk, $39.95. Vernier Software (see address above).

Ray Tracer, a program on the laws of geometrical optics. See how light behaves when you place various interfaces and optical devices on the screen and produce ray diagrams. For the Apple II; floppy disk, $24.95. Vernier Software (see address above).

Secur-A-Text, a data-encryption/decryption program that prevents files from being loaded into your computer unless you know the master- and local-code key numbers for access. For the Apple II; floppy disk, $49.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

Stan, a statistical-analysis system. You can enter data to analyze for variance or regression coefficients and produce a graph. For the Apple II; floppy disk, $300. Statistical Consultants, Park Plaza Office Bldg., 462 East High St., Lexington, KY 40508.

Taxmode, a tax-planning program. You can compute the components of individual federal income tax liability for the years from 1980 to 1985 according to current tax laws. For the Apple II Plus; floppy disk, $250. J. P. Sawhney & Co. Inc., 888 Seventh Ave., New York, NY 10106.

Trickster Coyote, an educational word game that will help increase a child's vocabulary. With animations in high-resolution graphics and sound, this program is for four players age 8 and older and includes a built-in dictionary. For the Apple II; floppy disk, $48.96. Reader's Digest Services Inc., Microcomputer Software Div., Pleasantville, NY 10570.

Word Attack, a four-part educational word-game program helps build vocabulary skills by displaying up to 675 words in illustrative sentences for students age 8 through adult. For the Apple II Plus; floppy disk, $49.95. Davidson & Associates, 6069 Groveoak Place #12, Rancho Palos Verdes, CA 90274.

Atari

P.M.P. 2000, a property-management program. This program is a template for Visicalc to help you maintain status reports, invoicing, and income/expense schedules on rental properties. For the Atari 800; floppy disk, $219.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

Reactor, an arcade-type game. Your ship is trapped in a nuclear reactor. You must bounce dangerous nuclear particles into the control rods to prevent a meltdown of the reactor. For the Atari Video Game System; cartridge, $30. Parker Brothers, POB 1012, Beverly, MA 01915.

Slot Trivia, a question-and-answer game. If you can answer a trivia question in one of eleven categories, the slot machine will pay off. For two players. For the Atari 400/800; floppy disk, $29.95. T & F Software Co. (see address above).

Survival of the Fittest, a strategy game. You and another player design colonies of organisms and fight for resources and space in a struggle for survival. For the Atari 400/800; cartridge, $39.95. Innovative Design Software Inc., POB 1658, Las Cruces, NM 88004.

CP/M

Buysel, several mathematical-analysis programs. This package is designed to help investors decide what to buy and sell in the stock, commodities, and options markets. For CP/M-based systems; floppy disk, $125 (Canadian funds). Software City, 35 Downsview Cres., Nepean, Ontario K2G 0A4, Canada.

Calendar/1, a calendar-generation program that lets you print out a personalized calendar displaying your events planned for each day. Formatting commands allow for customized calendar designs. For CP/M-based systems; floppy disk, $60. Clear Systems, Suite 404, 309 Santa Monica Blvd., Santa Monica, CA 90401.

E/T, a text-oriented screen editor. This program offers all essential editing features. It can be reconfigured for different terminals and automatically backs up your files. For

CP/M-based systems; 8-inch floppy disk, $95. Softwest Products, 11379 Kelowna Rd., San Diego, CA 92126.

M/PC, a custom disassembler. This program will disassemble an unmodified version of CP/M 2.2. It also provides a source code complete with labels and comments keyed to each address. For CP/M-based systems; 8-inch floppy disk, $35. C. C. Software, 2564 Walnut Blvd. #106, Walnut Creek, CA 94598.

Mailmate, a database-management program. Any of 15 fields of data entry in this program can be used for a sort or search. It also maintains mailing-label and customer lists, and can merge with some word-processing programs. For CP/M-based systems; floppy disk, $99. Computerworks Inc., 4010-A Carlisle NE, Albuquerque, NM 87107.

Micro Pascal, a Pascal subset compiler that is specifically designed for control and interface applications. It requires 24K bytes of memory and includes a runtime program. For CP/M-based systems; floppy disk, $175. Muson Engineering, 417 Montana Circle, Ojai, CA 93023.

Pathfinder, a project-planning and scheduling system. This set of four programs uses the critical path method to assist in the scheduling of up to 500 activities. For CP/M-based systems; 8-inch floppy disk, $500. Garland Publishing Inc., 136 Madison Ave., New York, NY 10016.

RXWRITER, a prescription-writing program for physicians that maintains a list of drugs, prints two copies of each prescription, and creates a patient/prescription file. For CP/M-based systems; 8-inch floppy disk, $50. Hall Design, 250 Maple St., Wilmette, IL 60091.

Rhesus is an erased-file recovery program that recovers accidentally erased files not yet overwritten by other disk operations. It features both automatic- or user-controlled functions and help screens. For CP/M-based systems; floppy disk, $65. Olsen Software, POB 91, Van Nuys, CA 91408.

Commodore

Cosmic Bandit, an arcade-type game in which your task is to prevent the alien hordes from freeing their compatriots locked in the space jail. For the Commodore PET/CBM; floppy disk, £6. Supersoft, Winchester House, Canning Rd., Wealdstone, Harrow, Middlesex HA3 7SJ, England.

Cosmic Lemmings, an arcade-type game. Your mission is to destroy the aliens as they drop toward you from their mother ship. For the Commodore PET/CBM; floppy disk, £8. Supersoft (see address above).

The Cracks of Doom, an adventure-type game loosely based on *Lord of the Rings.* Features include a help command that may tell you something useful. For the Commodore PET/CBM; floppy disk, £16. Supersoft (see address above).

Goblin Towers. Designed as a starter game, this adventure will teach you many of the skills necessary to try more difficult games. For the Commodore PET/CBM; floppy disk, £14. Supersoft (see address above).

Lemuria, an adventure-type game. Lemuria and Atlantis, two superpowers of the ancient world, have ended diplomatic relations. You are able to plan their destinies. For the Commodore 64; cassette, $8.95. RSVP Inc., 1332 Old Bridge Rd., Fort Myers, FL 33903.

Sidebar. This utility program lets you construct, edit, and save horizontal bar graphs with up to 17 variables. Graphs may then be reviewed, edited, and stored on tape. For the Commodore VIC-20; cassette, $9.60. MFJ Electro Enterprises, POB 13076, Kanata, Ontario K2K 1X3, Canada.

Super Glooper, an arcade-type game. Four glooper eaters chase you around the maze as you gather dots to increase your score. If you eat a large dot, you can eat all of the gloopers. For the Commodore PET/CBM; floppy disk, £8. Supersoft (see address above).

Tank Zone, an arcade-type game. It's kill or be killed in this simulation of desert warfare. You must avoid the tanks and missiles that are trying to destroy you. For the Commodore PET/CBM; floppy disk, £8. Supersoft (see address above).

Typing Package. This touch-typing instructional program can be used alone or in a classroom. It includes a warm-up, type drill, and typing test. For the Commodore VIC-20; cassette, $12.75. MFJ Electro Enterprises (see address above).

VIC-20 Games Pack, a set of five arcade-type games that includes Alien Blitz, Invaders, Ground Attack, Storm, and Space Rocks. For the Commodore VIC-20; cassette, $14.95. Melbourne House Software Inc., 333 East 46th St., New York, NY 10017.

Word Search, an educational word game. You have 10 minutes to find 20 different words in any of three puzzles: Animals, Jumbled, or States and Capitals. For the Commodore VIC-20; cassette, $19.95. T & F Software Co., 10902 Riverside Dr., North Hollywood, CA 91602.

IBM Personal Computer

Buysel, several mathematical-analysis programs (see description under CP/M). For the IBM Personal Computer; floppy disk, $125 (Canadian funds). Software City, 35 Downsview Cres., Nepean, Ontario K2G 0A4, Canada.

Cosmic Crusader, an arcade-type game in which your mission is to prevent a fleet of alien ships from reaching Earth. You must track them down, dodge their torpedoes, and destroy each ship. For the IBM Personal Computer; floppy disk, $38.95. Funtastic Inc., 5-12 Wilde Ave., Drexel Hill, PA 19026.

Curvfit-3D, a polynomial surface-fitting program. High-resolution graphics permit 2-dimensional or 3-dimensional isometric plotting for visual analysis of statistical data. For the IBM Personal Computer; floppy disk, $90. Petrospec, POB 3122, Richardson, TX 75080.

Easywriter II. Different from the IBM-distributed Easywriter 1.1, this word-processing program allows you to type in and edit text in a page- and mode-oriented environment. A utility pro-

gram is provided to transfer files to and from single-sided PC-DOS disks. For the IBM Personal Computer; floppy disk, $350. Information Unlimited Software Inc., 2401 Marinship Way, Sausalito, CA 94965.

Edix, a text-editing program to be used in conjunction with the Wordix formatting program. Edix offers four on-screen editing windows and online tutorial lessons that teach you how to use editing commands such as flexible pattern search. For the IBM Personal Comuter with PC-DOS; floppy disk, $195. Emerging Technology Consultants Inc., 2031 Broadway, Boulder, CO 80302.

The Final Word, version 1.1, a word-processing program. A recent addition to a series of programs inspired by Richard Stallman's EMACS, this program offers multiple text buffers, two editing windows, and versatile formatting capabilities. A swap file on disk preserves text in the event of a system crash. For the IBM Personal Computer with PC-DOS; floppy disk, $300. Mark of the Unicorn Inc., POB 423, Arlington, MA 02174.

General Ledger, this accounting package is part of a series of accounting packages that helps you establish and maintain a general ledger. For the IBM Personal Computer; floppy disk, $199. Micro Architect Inc., 96 Dothan St., Arlington, MA 02174.

Pmate. Suitable for program source-code-file and general text editing, this text-editing program offers a full selection of primitive functions that can be combined into macrocommands to perform high-level tasks. For the IBM Personal Computer with PC-DOS; floppy disk, $225. Lifeboat Associates, 1651 Third Ave., New York, NY 10028.

Powertext, version 1.8, a word-processing program. Based on the editing structure of the UCSD p-System, Powertext provides extensive capabilities for putting text into different formats. Form letter, document, and memo are a few of the possible files. For the IBM Personal Computer; floppy disk, $399. Beaman Porter Inc., Pleasant Ridge Rd., Harrison, NY 10528.

Newkeys, a utility program that lets you reconfigure the functions of your IBM PC keyboard by transforming it into a standard IBM Selectric or the Dvorak layout. For the IBM Personal Computer; floppy disk, $19.95. Magi Software, 564 Chinquapin Dr., Eglin, FL 32542.

Nutritionist, a diet-analysis program (see description under Apple). For the IBM Personal Computer; floppy disk, $145. N-Squared Computing, 5318 Forest Ridge Rd., Silverton, OR 97381.

Versatext, a word-processing and database system that includes the modules PCWriter, PCProcessor, PCBase, and PCGiant. For the IBM Personal Computer with PC-DOS; floppy disk, $199.95. Texasoft, 1028 North Madison Ave., Dallas, TX 75208.

Volkswriter, version 1.2, a word-processing program. This program provides a variety of fast editing functions for beginners using word processing. Function keys are used for editing commands; other commands are invoked from on-screen menus. For the IBM Personal Computer with PC-DOS; floppy disk, $195. Lifetree Software Inc., Suite 342, 177 Webster St., Monterey, CA 93940.

Word Attack, an educational word game (see description under Apple). For the IBM Personal Computer; floppy disk, $49.95. Davidson & Associates, 6069 Groveoak Place #12, Rancho Palos Verdes, CA 90274.

Word Wand, a word-processing program. This page-oriented program supports the French-language character set. For the IBM Personal Computer with Monochrome Display Adapter and PC-DOS; floppy disk, $340 ($400 Canadian funds). Tanda Software Inc., POB 244, Orleans, Ontario K1C 1S7, Canada.

Wordstar, version 3.2, a word-processing program. This well-known product has been adapted from its CP/M-80 version with few changes. It features a multiple-menu command structure and on-screen text formatting. For the IBM Personal Computer with PC-DOS; floppy disk, $495. Micropro International Corp., 33 San Pablo Ave., San Rafael, CA 94903.

Texas Instruments

Digger Duck, an interactive maze game that requires strategy and patience. For the TI-99/4A; cassette, $13.99. Vaughn Software, 5460 Harlan #84, Arvada, CO 80002.

Mariner, a maze-type puzzle game. As a seafaring adventurer, you must navigate through waters of changing depths using sight and sonar. For the TI-99/4A; cassette, $16.99. Vaughn Software (see address above).

Submarine Warrior, an arcade-type game. You pilot a submarine through enemy waters diving and surfacing to avoid mines, whales, and depth changes. You can fire your missiles at targets for a high score. For the TI 99/4A; cassette, $11.95. JW Software, 814 West Main St., Urbana, IL 61801.

Timex/Sinclair

Catacombs, an adventure-type game. You are lost in one of several levels of the catacombs. In your struggle to survive you must locate food and gold while avoiding phantoms and monsters. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melbourne House Software Inc., 333 East 46th St., New York, NY 10017.

Gamestape I, a set of 11 game programs that includes Klingons, Crash Landing, Simon, UFO, Code, Asteroids, Bomber, Guillotine, Breakout, and others. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melourne House Software Inc. (see address above).

Gamestape 2, a set of three programs. Included are Starfighter, a space battle game; Pyramid, a strategy game; and Artist, a graphics-design program. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melbourne House Software Inc. (see address above).

3D Monster Maze, an arcade-type game. See if you can find your way out of the maze with a Tyrannosaurus Rex chasing you. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melbourne House Software Inc. (see address above).

3D Orbiter, an arcade-type game. You command the last surviving craft of your army. To defend your civilization you must battle against marauding invaders as you climb, bank, and dive in outer space. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Melbourne House Software Inc. (see address above).

Videocalc, an electronic-spreadsheet program that lets you input data and mathematical formulas and immediately see the answers. The program uses Sinclair BASIC functions. For the Timex/Sinclair 1000 and ZX81; cassette, $9.95. P & B Software, 1155 East Malibu Dr., Tempe, AZ 85282.

ZXAD, an assembler/debugger. Assembler uses the entire Z80 instruction set and standard mnemonics. Source statements are entered as BASIC remark statements. Debugger displays or alters memory. For the Timex/Sinclair 1000 and ZX81; cassette, $14.95. Scientific Software, 6 West 61 Terrace, Kansas City, MO 64113.

TRS-80

Arachnid Plus, a set of three arcade-type games. In Arachnid you fight against a spider-like creature. In Warzone you must trap your opponent in a maze of squares. In Baja you race your dune buggy across a treacherous desert course. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack, 1691 Eason, Pontiac, MI 48054.

Assault, an arcade-type game. You must struggle to prevent various creatures from stealing your bags of gold. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Cyborg, an arcade-type game. Try to collect all 12 signal modules in your complex while avoiding or killing threatening robots. If you succeed, you can move on to more difficult complexes. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Deadline, an interactive game. You are a detective who must solve a murder within 12 game hours. The program gives you all the clues you need. For the TRS-80 Model III; 5¼- and 8-inch floppy-disk formats, $49.95 and $59.95, respectively. For information, contact Infocom, 55 Wheeler St., Cambridge, MA 02138.

Financial Planning for Visicalc, a set of 17 templates for use with the Visicalc electronic-spreadsheet system. For the TRS-80 Model II; floppy disk, $59.95. Howard W. Sams & Co. Inc., 4300 West 62nd St., POB 7092, Indianapolis, IN 46206.

Hexman, a disk-management system. The Hexman program runs under LDOS and can monitor file activity for easier storage and retrieval. It also makes daily backups of modified files. For the TRS-80 Models I and III; floppy disk, $169. Hexagon Systems, POB 397, Station A, Vancouver, British Columbia V6C 2N2, Canada.

Jovian, an arcade-type game. The Jovians are archenemies of Earth and must be stopped. If you can hit their space stations with your rapid-fire plasma bullets you will destroy them. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Liberator, an arcade-type game. Your robot has gone berserk and hidden your four assistants in a hazardous industrial park. Rescue your assistants while avoiding the robot. For the TRS-80 Models I and III; floppy disk, $24.95. Computer Shack (see address above).

Listmaker, a database-management program that can handle lists for business, home, or school; personalize and print form letters; and sort and search on one or multiple fields. For the TRS-80 Models I and III; floppy disk, $97.50. Reader's Digest Services Inc., Microcomputer Software Division, Pleasantville, NY 10570.

Starcross, an adventure-type game. Your ship has found a gigantic alien starship. In order to discover its treasures, you must dock and explore its mysterious interior. For the TRS-80 Model III; 5¼- and 8-inch floppy-disk formats, $39.95 and $49.95 respectively. For information, contact Infocom, 55 Wheeler St., Cambridge, MA 02138.

T.B.B.S., an electronic bulletin-board system. You can custom design your own system format without writing a program code. Set up your own computerized message board from 25 types. For the TRS-80 Models I and III; floppy disk, $149.95. Ebert Personal Computers Inc., 4122 South Parker Rd., Aurora, CO 80014.

Other Computers

Buysel, several mathematical-analysis programs (see description under CP/M). For CDOS/Cromix; floppy disk, $125 (Canadian funds). Software City, 35 Downsview Cres., Nepean, Ontario K2G 0A4, Canada.

Portfolio Manager, a stock-management program. Enter current stock prices and you receive a one-page report showing 19 classes of information about your stock. For the Heath/Zenith H-/Z-89; floppy disk, $25. RCK Associates, 640 Trephanny Lane, Wayne, PA 19087.■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Books Received

Apple Files, David Miller. Reston, VA: Reston Publishing Co., 1982; 414 pages, 38 by 56 cm, hardcover, ISBN 0-8359-0192-0, $19.95.

Atari PILOT for Beginners, Jim Conlan and Tracy Deliman. Reston, VA: Reston Publishing Co., 1983; 229 pages, 36 by 54 cm, softcover, ISBN 0-8359-0301-X, $14.95.

Atari Sound and Graphics, A Self-Teaching Guide, Herb Moore, Judy Lower, and Bob Albrecht. New York: John Wiley & Sons, 1982; 234 pages, 40.6 by 60 cm, softcover, ISBN 0-471-09593-1, $9.95.

BASIC Exercises for the IBM Personal Computer, J. P. Lamoitier. Berkeley, CA: Sybex, 1982; 251 pages, 42 by 54 cm, softcover, ISBN 0-89588-088-1, $13.95.

A BASIC Programmer's Guide to Pascal, Mark J. Borgerson. New York: John Wiley & Sons, 1982; 118 pages, 40.6 by 60 cm, softcover, ISBN 0-471-09293-2, $9.95.

CICS/VS Command Level with ANS COBOL Examples, Pacifico A. Lim. New York: Van Nostrand Reinhold, 1982; 576 pages, 38 by 56 cm, hardcover, ISBN 0-442-22607-1, $29.95.

Communications and the Future, Prospects, Promises, and Problems, Howard F. Didsbury Jr., ed. Bethesda, MD: World Future Society (4916 St. Elmo Ave.), 1982; 357 pages, 36 by 54 cm, softcover, ISBN 0-930242-16-5, $14.50.

Computer Simulation in Business, Hugh J. Watson. New York: John Wiley & Sons, 1981; 358 pages, 46 by 56 cm, hardcover, ISBN 0-471-03638-2, $28.95.

The Creative Apple, Mark Pelczarski and Joe Tate, eds. Morristown, NJ: Creative Computing Press (POB 789M), 1982; 448 pages, 50 by 65.6 cm, softcover, ISBN 0-916688-25-9, $15.95.

The DP Professional's Guide to Writing Effective Technical Communications, J. Van Duyn. New York: John Wiley & Sons, 1982; 218 pages, 40 by 57 cm, hardcover, ISBN 0-471-05843-2, $22.95.

Fast BASIC, Beyond TRS-80 BASIC, George A. Gratzer with Thomas G. Gratzer. New York: John Wiley & Sons, 1982; 278 pages, 40.6 by 60 cm, softcover, ISBN 0-471-09849-3, $14.95.

Handbook of Advanced Robotics, Edward L. Safford Jr., Blue Ridge Summit, PA: Tab Books, 1982; 468 pages, 31 by 49.6 cm, softcover, ISBN 0-8306-1421-4, $15.95.

How to Buy a Personal Computer, Carlton Shrum. Sherman Oaks, CA: Alfred Publishing Co. (POB 5964), 1982; 64 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-188-2, $2.95.

How to Select a Business Computer, Billie Cayot, David Campbell, and Norm Stone. Oakland, CA: Oasis Press (POB 6836), 1982; 215 pages, 63 by 70 cm, hardcover, ISBN 0-916378-17-9, $29.95.

The Illustrated Word Processing Dictionary, Russell A. Stultz. Englewood Cliffs, NJ: Prentice-Hall, 1983; 170 pages, 37 by 56 cm, hardcover, ISBN 0-13-450726-6, $17.95.

Information Resource Management, Opportunities and Strategies for the 1980s, William R. Synnott and William H. Gruber. New York: John Wiley & Sons, 1981; 356 pages, 40 by 57 cm, hardcover, ISBN 0-471-09451-X, $27.95.

Inside CP/M, David E. Cortesi. New York: Holt, Rinehart and Winston, 1982: 571 pages, 44.6 by 55.6 cm, softcover, ISBN 0-03-059558-4, $23.95.

Introduction to BASIC Programming, Gary B. Shelly and Thomas J. Cashman. Brea, CA: Anaheim Publishing Co. (2632 Saturn St.), 1982; 406 pages, 44 by 55 cm, softcover, ISBN 0-88236-118-X, $14.95. Includes transparency masters.

An Introduction to Computers and Information Processing, Robert A. Stern and Nancy Stern. New York: John Wiley & Sons, 1982; 637 pages, 45.6 by 56.6 cm, hardcover, ISBN 0-471-08723-8, $20.95.

Introduction to Computer Architecture and Organization, Harold Lorin. New York: John Wiley & Sons, 1982; 311 pages, 40 by 57 cm, hardcover, ISBN 0-471-86679-2, $25.

Learning BASIC Step by Step, Vern McDermott and Diana Fisher. Rockville, MD: Computer Science Press, 1982; 139 pages, 52 by 32 cm, hardcover, ISBN 0-914894-49-8, $15.95.

The Microcomputer Builders's Bible, Chris Johnston. Blue Ridge Summit, PA: Tab Books, 1982; 314 pages, 30.6 by 49.6 cm, softcover, ISBN 0-8306-1473-7, $12.95.

1983 Classroom Computer News Directory of Educational Computing Resources. Watertown, MA: Intentional Educations (341 Mt. Auburn St.), 1982; 201 pages, 50 by 66 cm, softcover, ISBN 0-9607970-0-9, $14.95.

The Power of Multiplan, Robert E. Williams. Portland, OR: Management Information Source (3543 Northeast Broadway), 1982; 168 pages,

Books Received

51 by 64.6 cm, softcover, ISBN 0-13-687343-X, $14.95.

Practical BASIC Programs: IBM Personal Computer Edition, Lon Poole, ed. Berkeley, CA: Osborne/McGraw-Hill, 1982; 170 pages, 50 by 65 cm, softcover, ISBN 0-931988-80-2, $15.99.

Programming the IBM Personal Computer: BASIC, Neill Graham. New York: Holt, Rinehart and Winston, 1982; 287 pages, 42 by 55 cm, softcover, ISBN 0-03-061911-4, $16.95.

Programming the TI-59 & the HP-41 Calculators, Paul Garrison. Blue Ridge Summit, PA: Tab Books, 1982; 294 pages, 31 by 50 cm, softcover, ISBN 0-8306-1442-7, $12.95.

Science and Engineering Sourcebook, Cass R. Lewart. Englewood Cliffs, NJ: Prentice-Hall, 1982; 96 pages, 36 by 54 cm, softcover, ISBN 0-942412-02-8, $9.95.

Software Blueprint and Examples, Yaohan Chu. Lexington, MA: Lexington Books, 1982; 519 pages, 40 by 56 cm, hardcover, ISBN 0-669-05329-5, $39.95.

Structured Programming Using PL/1, 2nd ed., J. N. P. Hume and R. C. Holt. Reston, VA: Reston Publishing Co., 1982; 400 pages, 43.6 by 57 cm, hardcover, ISBN 0-8359-7133-3, $19.95.

TRS-80 Color Basic, Bob Albrecht. New York: John Wiley & Sons, 1982; 378 pages, 40.6 by 60 cm, softcover, ISBN 0-471-09644-X, $9.95.

Understanding BASIC, Richard G. Peddicord. Sherman Oaks, CA: Alfred Publishing Co. (POB 5964), 1981; 48 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-146-7, $2.95.

Understanding COBOL, Richard G. Peddicord. Sherman Oaks, CA: Alfred Publishing Co. (POB 5964), 1981; 47 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-147-5, $2.95.

Understanding Computers, Donald D. Spencer. Ormond Beach, FL: Camelot Publishing Co. (POB 1357), 1982; 400 pages, 36 by 54 cm, softcover, ISBN 0-89218-057-9, $13.95.

Understanding Computers, What Managers and Users Need to Know, Myles E. Walsh. New York: John Wiley & Sons, 1982; 266 pages, 35 by 54 cm, softcover, ISBN 0-471-87417-5, $14.95.

Understanding Data Base Management, Michael J. Freiling. Sherman Oaks, CA: Alfred Publishing Co. (POB 5964), 1982; 63 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-221-8, $2.95.

Understanding FORTRAN, Herbert R. Ludwig. Sherman Oaks, CA: Alfred Publishing Co. (POB 5964), 1981; 63 pages, 25.6 by 66 cm, softcover, ISBN 0-88284-148-3, $2.95.

Up the EDP Pyramid, The Complete Job Hunting Manual for Computer Professionals, Jack French. New York: John Wiley & Sons, 1982; 185 pages, 35 by 54 cm, softcover, ISBN 0-471-87117-6, $12.50.

Visicalc by the User for the User, Jim Englander, ed. Scarsdale, NY: Intercalc (POB 254), 1982; 80 pages, 51 by 66 cm, softcover, ISBN 0-911095, $10.

Word Processing Handbook, Ivan Flores. New York: Van Nostrand Reinhold, 1983; 552 pages, 38 by 56 cm, hardcover, ISBN 0-442-22526-1, $34.50. ■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

Ask BYTE

Conducted by Steve Ciarcia

Travelling Computers

Dear Steve,

We are considering buying a personal computer and have been looking for information in BYTE. We currently live in the Philippines, which makes comparison shopping difficult: information is limited and somewhat dated. We will be home on leave in the fall and hope to bring a computer back with us. We would appreciate any information, advice, or suggestions you might give us on computers, peripherals, and so on. We would like a computer for the following:

- Word processing, especially letter-quality printing. Is there a dot-matrix impact printer that would be satisfactory, or are formed characters necessary?
- We play complex strategy/tactics games, such as recreating World War II battles. Which computer has the best, most complex games of this type? Do you know any company besides Avalon Hill that makes this type of game?
- Educational programs for a ninth grader.
- Color graphics and color video monitor are a must. Is a color monitor suitable for word processing? designing needlepoint?
- We'd like to catalog a stamp collection, keep track of constantly changing titles in a small library, and have a typing tutor.
- What about future expansion?

We would like to stay under $4000. Size and weight are important. How necessary are two disk drives? Would a double-sided double-density disk drive be worth the extra cost? Shape is also a factor. Three of us have to bring it back on a plane. Reliability is most important; service here is nonexistent or of dubious quality. We will probably not be back in the States for at least two years.

In the Philippines, there are power fluctuations and outages. We have air conditioning, but with the power out, it's hot and humid. There are lots of insects and dust. If these conditions don't prohibit a computer, how do we protect it?

Finally, can an 8-bit computer have more than 64K bytes of user memory? Thank you for your help.

Ronald A. Alasin
Philippines

Choosing a computer for your applications is not half as difficult as determining the reliability of such a unit in the environment you describe. Let's address that aspect first.

Any computer that you purchase in the States will be designed to run off of 120 V (volts) at 60 Hz (hertz) AC. If your power in the Philippines is different than this, you will need a power converter and possibly a means to change the line frequency. One way around this would be to obtain a power inverter that would convert 12 V DC to 120 V AC at 60 Hz. This unit could then be powered by either battery or a 12-V DC supply designed for the local power requirements.

If power outages and fluctuations are frequent, you must assess the impact on your computing tasks. If you are greatly inconvenienced by fluctuations and outages (which cause the computer to crash), then an uninterruptible power supply may be required. This is a unit that instantly (for all practical purposes) switches from line to battery power in the event of an outage.

Insects and dust will be detrimental to your disks unless you take proper precautions. The heat may or may not be a problem, depending on the length of time that the computer is in use and whether or not it has a built-in fan.

As far as reliability is concerned, one must examine the record of the computers now on the market. Certainly, those that have been in production for awhile have had time to establish a reputation.

Because high-resolution graphics and color are requirements, and a large variety of software is suggested, I would lean toward either the Apple II or Apple IIe computer. You may need several accessory boards to drive a printer and an 80-column screen, but for your price range, it is a good choice. The Apple II has been around long enough to establish its reliability. One disk drive should suffice for most applications, but an extra drive adds convenience. Double-sided, double-density disks are not worth the extra price, in my opinion. Many disk manufacturers frown on using both sides of a disk beause it adds extra abrasion to the data on the first side. In your dusty environment, it is not worth the chance.

For letter-quality printing, a high-quality dot-matrix printer should suffice, but this is a personal choice. Some pretty good letter-quality daisy-wheel printers costing less than $1000 are on the market. They are not terribly fast, but their reliability seems to be acceptable.

An 8-bit computer can have more than 64K bytes of memory, but it addresses only 64K bytes at any one time. A technique known as bank selecting *is used to enable one of several 64K-byte blocks of memory.*

Finally, Strategic Simulations (Suite 108, 465 Fairchild Dr., Mountain View, CA 94043) has a variety of complex strategy/tactic games for the Apple II. I hope that this gives you some guidelines on your purchases. Buy before you leave and run all units for as long as possible then so that any premature failures can be corrected. . . . **Steve**

Inside Level II ROMs

Dear Steve,

I have a TRS-80 Model I Level II. I presently write 99% of my programs in machine-language. As you know, there are a lot of programs in the Model I's ROM (read-only memory) that handle, for example, the keyboard. I called Radio Shack to get a source-code listing of those programs, but they are not available. Can you tell me where I can get those listings?

Francois Paquin
Sarnia, Ontario, Canada

Mumford Micro Systems has a book that explains the inner workings of the Radio Shack TRS-80 Models I and III Level II ROMs. It contains information on set-ups, calling sequences, and variable passage for number conversion, arithmetic operations, etc. In addition, it is a very useful reference manual with information on RAM usage, relocation of BASIC programs, USR call expansion, and creating system tapes of your programs. The book, Inside Level II—The Programmer's Guide to the TRS-80 ROMs, *costs $15.95 (plus $2 postage) and can be ordered from Mumford Micro Systems, POB 400-D, Summer-*

land, CA 93067, (805) 969-4557. . . . **Steve**

Colorful Computer Questions

Dear Steve,

I'm wondering if you, or some of your readers, could answer a couple of questions regarding the Radio Shack Color Computer.

1. Is there any way to get more than 32 characters per line? I bet someone is working on it, but I haven't seen any solutions except that achieved by Cognitec in its Telewriter word-processing program.
2. Have you any information on a BASIC compiler for the Motorola 6809 in the Color Computer (or does the type of processor make very much difference anyway)? It sure would be handy.

Thanks.

Duff Kennedy
Santa Barbara, CA

The video-display format for the Radio Shack Color Computer is controlled by the Motorola 6847 Video Display Generator chip, and the number of characters per line that are displayed on the screen is a function of the mode that the chip is in. For alphanumerics, the format is 16 lines of 32 characters each. Using the high-resolution graphics mode of 256 by 192 pixels, an alternate character set can be graphically defined and more characters obtained. For example, if a 5 by 7 font is used with one blank dot between characters, then 256/6=42 characters per line. See "What's Inside Radio Shack's Color Computer," by Ahrens, Browne, and Scales (March 1981 BYTE, page 90).

I'm sorry but I don't have any information on a BASIC compiler for the 6809. . . . **Steve**

More Colorful Questions

Dear Steve,

In the May 1982 BYTE, you answered a question about video-display problems on the TRS-80 Color Computer (see "TV Jitter Bugs," page 398). You did not comment on one proposed solution to the problem of interference: is it possible to remove the RF (radio-frequency) modulator and go directly to a video monitor? What about the sound? Because most monitors have a sound input, is it possible to tie that output directly to a monitor?

Thanks for the help.

Mark Ososki
Mount Clemens, MI

If the interference problem referred to in that Ask BYTE letter was caused by the vertical synchronization signal being slightly off frequency, removing the RF modulator will not solve the problem. The modulator only takes the composite-video signal (video, horizontal synchronization, and vertical synchronization) and superimposes a carrier signal upon it so that the video may be received on a television set.

The RF modulator can be removed from the Color Computer. The composite-video signal is then available at pin 1 of the modulator unit and the sound is at pin 3. These outputs can then be fed into the sound and video inputs of a monitor. Of course, the standard caution of voiding the warranty by tampering with the computer applies. . . . **Steve**

ZX81 Power Backup

Dear Steve,

One rainy day, when just finishing a perfect program on

my ZX81, the power went out and I lost my program. I want to prevent this from happening again. Do you know of any way to add battery backup to the ZX81 without spending a lot of time and money?

The ZX81 requires 9.75 V (volts) at 650 milliamperes (mA); however, my multitester indicates that the AC line adapter puts out 15 V without the computer connected. Also, what is the amperage available from a common 9-V battery?

Z. Smith
West Grove, PA

One way to prevent power loss to your Sinclair ZX81 is to use a 12-V DC supply with an automotive storage battery in parallel across it. The ZX81 has a 5-V regulator inside to drop the input voltage to the necessary 5 V, and with a 12-V input, only a little extra heat will be generated. If this is undesirable, a series-dropping resistor between the power supply and the ZX81 will restore original conditions. In the event of a power failure, the computer will continue to run from the storage battery. When power is restored, the DC supply will take over and also recharge the battery.

A common 9-V battery has a current output of 20 to 40 mA; many would need to be paralleled to drive the computer. The AC line adapter output measures 15-V because there is no load in the circuit. If you put a load (such as the computer) across the supply, the voltage will drop to the specified range. . . . **Steve**

Hot and Cold Computers

Dear Steve,

Have briefcase computers been tested in variable temperature situations? Going from a 75° F house to the car in the winter at −25° F might cause some type of electronic damage or damage to the floppy disks that are stored in the units (as in the Osborne). I live in Wisconsin. Considering the wide temperature range, should I buy a portable computer?

Paschal A. Frigo
Green Bay, WI

You raise an interesting question. Shugart, for example, specifies an ambient operating temperature range for its Model SA 400 floppy-disk drive of 40° to 115° F. As the temperature drops, the potential for mechanical sluggishness increases and this may result in erratic data transfers.

Floppy disks have a storage requirement of 50° to 125° F. One can only guess as to the flexibility of a disk at extremely low temperatures. If there is valuable data on the disk, I would not leave it exposed to low temperatures.

The electrical functioning should be less sensitive, but a general rule would be to allow the unit to warm to approximately room temperature before powering up. The thermal change in going from a warm building to a cold car should cause no problem, assuming that the car has a heater which will be in use. The short time at the temperature extremes will not markedly affect the unit's internal temperature. . . . **Steve**

Follow-up and Music to His Ears

Dear Steve,

This letter is a follow-up to my letter about adding lowercase display characters to a Lear Siegler ADM 3A terminal. (See "ADM 3 Lowercase Conversion," October 1982 BYTE, page 453.) You kindly referred me to an article published in the March

1979 BYTE and suggested that I get the 2513 ROM (read-only memory) from Active Electronics. I tried to do this, but they were back ordered.

I then noticed a ROM sold by Advanced Computer Products in Santa Ana, California, called the 2513-ADM. When I called the company, the only information I could get was that it was made by General Instrument. Upon calling that company, I received a firm denial that General Instrument ever made a ROM with inverted outputs as needed by the ADM 3A. I decided to take a chance and ordered the chip for $14.95, along with the specification sheet.

The specification sheet sent with the chip was for a 2513-RO-3, not for the 2513-102 as labeled on the chip. Thoroughly confused, I boldly put the chip in the socket in the ADM 3A and—lo and behold—lowercase characters appeared without any soldering or tinkering!

I have gone into such detail on this issue because I thought your readers might be interested in knowing about this orphan chip that no one claims (although it is marked as being made by General Instrument) and that no one knows anything about.

I'd like to ask you another completely unrelated question. I would imagine that many people engrossed in computers are like me in that they started out with electronics as a result of an interest in high-fidelity and music. A few years back, all my spare cash went for buying high-fidelity equipment; now all of it goes for buying computer equipment. I would love to have my high-fi controlled by my computer (e.g., changing music sources from tape to tuner, adjusting the volume, switching speakers). The first and last are relatively easy, but I have not seen anything on the control of an analog circuit by a computer—especially one sensitive to noise. Could you suggest a circuit, or point me in the direction of one? I am a neophyte when it comes to electronics.

Thank you for your time and help. It's greatly appreciated.

Rich Bucholz
Hamden, CT

Thanks for the follow-up.

Controlling audio devices by means of a microcomputer is a relatively easy process, requiring the use of D/A (digital-to-analog) converters. A unit made by Analog Devices, the AD 7110 is a CMOS (complementary metal-oxide semiconductor) digitally controlled audio attenuator with an attenuation range of 88.5 dB (decibels), plus full muting capability. Its 6-bit digital input covers the attenuation range in 1.5 dB increments. Such a unit could control the audio amplitude in your stereo system.

The ADG201 is a CMOS-protected quad SPST (single-pole, single-throw) analog switch that can be toggled by a TTL- (transistor-transistor logic-) or CMOS-level logic input. It features a make-before-break switching action and has overvoltage protection to 25 volts above the supply voltage. In its "ON" state, it looks like a 100-ohm resistor. This can switch low-level signals in your system.

The data sheets for both these devices give an indication of their use. Handle them with extreme care because they are static sensitive. I have no circuits immediately available as the application of these devices to audio control is usually unique to each user. Write Analog Devices for further information and data sheets. The address is Analog Devices, Route One Industrial Park, POB 280, Norwood, MA 02062, (617) 329-4700. . . . **Steve**

Home Security 6502 Style

Dear Steve,

I am trying to implement that neat home-security system you outlined. (See "Build a Computer-Controlled Security System for Your Home," Part 1, January 1979 BYTE, page 56; Part 2, February 1979 BYTE, page 162; Part 3, March 1979 BYTE, page 150). Not being familiar with the 8080 series of processors, I am using a SYM-1 single-board computer, which is based on the 6502 microprocessor.

Because the flowcharts in the article are so clear and easy to program from, it occurred to me that there must be some literature describing in more detail the development of such "event processor" programs. If you could steer me toward some books or articles about this type of programming, I would be most grateful.

Eric A. Lowhar
Venice, CA

An excellent book on programming the 6502 microprocessor, with emphasis on interfacing and controlling applications, is Programming & Interfacing the 6502, With Experiments, *by Marvin L. De Jong (Howard W. Sams & Co. Inc., 4300 West 62nd St., POB 7092, Indianapolis, IN 46206). It costs $16.95. This book specifically addresses the SYM-1, AIM-65, and KIM-1 single-board computers. It should be in your reference library.*

An article in the October 1977 issue of Kilobaud *(page 84), "Dedicated Controllers" by Michael J. Myers, describes a specific application of a KIM-1 computer as a process controller. The software is described and should be of some help to you.* . . . **Steve**

Upgrading Homebrew to CP/M

Dear Steve,

I have an 8080A-based microcomputer that I designed and built. I am redesigning it with a Z80 and several refinements. It occurred to me that machine language was perhaps going to be a bit of a drag once I was past the development stage (are we ever?). What sort of hardware/bootstrap configuration would I need so that I could eventually add floppy-disk drives and run CP/M? I know that the boot-loader program must be limited to 256 bytes, and I'm familiar with the term BIOS, but that is about it.

I'm in Korea, and there is an acute lack of serious material on microcomputers. Can you give me any clues as to where to look? I would like to find out about necessary design changes before I wire-wrap the whole thing. Any help would be appreciated.

Sergeant Dale L. Botkin
South Korea

I would suggest that you configure your computer around the S-100 bus so as to take advantage of this simple means of adding a disk controller and CP/M to your system. Many of the S-100 disk-controller boards on the market are designed for CP/M and include a bootstrap PROM (programmable read-only memory) as part of the package or as an option.

Some of the disk-controller cards with this feature are the CCS Model 2422 (California Computer Systems), the Versafloppy (SD Systems), the Double-D (Jade), and the Disk 1 (Compupro).

These units can be obtained from Jade Computer Products, 4901 West Rosecrans Ave., Hawthorne, CA 90250,

and Priority 1 Electronics, 9161 Deering Ave., Chatsworth, CA 91311. Write for their catalogs. They also carry an extensive selection of books on microcomputers.
. . . **Steve**

Rounding Off Square Roots=Gray Hairs

Dear Steve,

A friend called me and asked me to do a short program on my Apple II Plus. He wanted a program that printed out the Pythagorean triplets between 1 and 20. After some work, I found that my Apple has some trouble calculating square roots.

The program shown in listing 1 should work, but it doesn't. The problem is in line 40. I found that the Apple has trouble with IF, THEN, and SQR functions when they are used together.

I went through a test program and I found something very unusual. First, I typed in LET X= SQR(100). We all know that X should equal 10, but just in case, I entered PRINT X. The computer responded with 10, but then came the problem. I entered print X = 10. If that statement is true, the computer should respond with 1, but it doesn't, it prints 0 (i.e., the statement is false). Now computers are likely to make some errors, but even my little brother knows that one!

I was wondering if you could tell me what was the cause of this. This error has kept me from doing quite a few programs for algebra and other classes of mine. Is it a flaw in the Apple, or is it just that my particular computer is messed up?

Joel Kozikowski
Indianapolis, IN

The problem that you have with the SQR function is not an error in Applesoft BASIC. In fact, it is not an error at all. You are correct in assuming that the problem is in line 40 of your program, but for the wrong reason. After taking the square root, you test for those values that are integers. The problem is that none of the square roots are integers due to the way that square roots are calculated.

Remember the pocket calculators that would give you 1.9999999 for the square root of 4? This is exactly what is happening in the Apple II. The algorithm that calculates square roots rounds off to a fixed number of significant digits. Because line 40 branches to line 60 if not an integer, your program just runs the nested loops and then ends.

Change line 40 to what's shown in listing 2, and your program will run correctly. This line tests to see how close C is to an integer value. If the difference between C and the integer C is very, very small, then it is an integer and will be printed. Otherwise, your computer will look for the next set of values.

Also, when you apply the test PRINT X = 10, the answer is false because X does not equal 10. It may equal 9.999999999 or 10.0000001 etc. and not 10.0000000000. This is a subtle mistake that creates lots of gray hairs for programmers. . . . **Steve**

Listing 1

```
10 FOR A = 1 TO 20
20 FOR B = A TO 20
30 LET C = SQR ( A*A + B*B)
40 IF C < > INT (C) THEN 60
50 PRINT A,B,C
60 NEXT B
70 NEXT A
```

Listing 2

```
40 IF C = ABS(C - INT (C)) > .00000001 THEN 60
```

FCC Requires Testing Lab's Approval

Dear Steve,

I am an avid reader of yours. Your projects really seem to hit home with my interests. I enjoyed listening to you speak at the Trenton Computer Festival last year and your comments concerning answering letters has prompted me to write.

I have experimented with adding devices to the telephone line. My interface, for the most part, consists of a 1-megohm resistor in series with the phone line and a 100k-ohm and 0.1 microfarad (μF) capacitor tied in parallel.

How can I get FCC approval for a device that connects to the phone? I would really like to sell these designs to a company that would be interested in building and marketing my prototypes.

Mark Kantrowitz
Rockaway, NJ

FCC approval requires the passage of tests that are best conducted by an independent testing laboratory. These laboratories are also familiar with the paperwork that must accompany such testing. One testing lab that I have used and can recommend is Art Schulze, 8807 Mobud Dr., Houston, TX 77036.
. . . **Steve■**

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033
If you are a subscriber to The Source, chat with Steve (TEC317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

IBM Unveils Top-of-the-Line Personal Computer

IBM recently unveiled its top-of-the-line microcomputer: the IBM Personal Computer XT. The XT, an extended version of the popular IBM PC, comes with a 10-megabyte hard-disk drive, 128K bytes of RAM (random-access read/write memory) that's expandable to 640K bytes, one 360K-byte floppy-disk drive, an asynchronous communications adapter, and eight expansion slots. It lists for $4995. Externally, it looks the same as its predecessor, and it still uses the 8088 microprocessor, but the XT is not the radical new computer that rumors had predicted. Nonetheless, it's a fine, conservative machine.

At the same time that the IBM Personal Computer XT was announced, company spokesmen also took the wraps off several optional accessories and enhancements for the Personal Computer line. IBM now offers expansion units for both the PC and the XT (with a hard disk and eight input/output slots), a high-resolution color display, and an enhanced version of Microsoft's disk operating system, DOS 2.0.

The basic XT provides a roomy storage area with its 10-megabyte hard-disk drive, allowing you to work with large data files and eliminating the need to swap around disks and programs. The availability of the IBM hard disk sets the stage for software developers who want to create new applications that require the greater storage capacity and faster access time of a hard disk.

The 360K-byte floppy-disk drive provides an easy way to transfer programs and data to or from the hard-disk system. Why IBM chose this new floppy-disk format with 180K bytes (single-sided) or 360K bytes (double-sided) per disk is somewhat perplexing because it doesn't offer much more space than the 160K- to 320K-byte-per-disk format on the PC. IBM DOS 2.0 supports this new disk format with nine sectors instead of eight. It is upward-compatible with PC-DOS 1.0 and 1.1 and can read and write all previous disk formats.

Backing up the hard disk to floppy disks is supported by a couple of new commands. A menu of several options lets you choose between copying the entire disk, selected files (via a wildcard format), all files created after a certain date, or only the files changed since the last backup.

Eight system expansion slots are an improvement over the IBM PC's five slots, but three slots are already taken up by adapters for the hard disk, the floppy disk, and asynchronous communications. If you get the expansion unit, a fourth slot will be used for an attachment card to link the two units together.

Only six of the eight slots in the IBM PC XT are for full-sized accessory cards. Because of space limitations, two slots are behind the disk drives. These slots accept smaller cards, such as the asynchronous communications, game controller, and printer adapters, or the attachment cards.

The IBM PC XT includes an asynchronous communications adapter that can be used to connect a serial printer or to communicate with IBM PCs, larger IBM mainframe systems, or other information sources via a modem.

The optional expansion unit with a 10-megabyte hard disk and eight more I/O slots comes in two configurations: one for the IBM PC and the other for the IBM PC XT. The expansion unit for the regular IBM PC differs only in that it contains a hard-disk adapter and is therefore more expensive. A single hard-disk adapter can handle two hard-disk drives, but each drive has to be in the same unit because of cabling requirements.

One of the full-sized slots will be used by the hard-disk adapter when it is moved from the IBM PC XT system unit to the expansion unit to handle the two hard disks. The expansion unit has an automatic, power-on self-test of the components, like the system unit does, and is not available without the hard disk.

For the first time, IBM is offering a color display monitor for its personal computers. This 16-color 12½-inch display is aggressively priced at $680 and provides resolution of up to 640 by 200 dots. Text can be shown in 25 lines of either 40 or 80 characters. A separate color/graphics monitor adapter controls the monitor.

A version of MS-DOS 2.0 for IBM's personal computers was also released. The IBM DOS 2.0 disk includes BASIC 2.0, which supports some of the new functions available under DOS 2.0, such as the hierarchical file directories and new graphics, music, and function-key enhancements.

Immediate price reductions on the IBM Personal Computer averaging 15 percent were also disclosed. The only items actually lowered in price are the system unit, disk drives, memory card, color/graphics monitor adapter, and asynchronous communications adapter. The IBM PC with 16K bytes of memory has been discontinued, and now 64K bytes of memory is the minimum configuration.

To make communications with corporate IBM mainframe computers easier, synchronous data-link control (SDLC) and binary synchronous communications (BSC) adapters are available. These adapters allow the IBM Personal Computers to emulate common IBM terminals.

For those companies that already have IBM 3270-type terminals and would like to add personal-computer capabilities, IBM has come out with the 3270 Personal Computer attachment. This allows you to use the 3270 keyboard and display as a terminal to a central computer, then switch to using the 3270 terminal as an IBM Personal Computer compatible with other IBM microcomputers.

By typing the alternate key with another key, you can jump back and forth between the two modes. You can even get data from the host computer and analyze it locally in the personal-computer mode.

The 3270 Personal Computer attachment consists of the 3278 Personal Computer adapter (an IBM PC system unit with disk drives), which is installed by an IBM service representative, and the Personal Computer 3278 attachment option, a card that you can plug into one of the unit's slots. If you have both a 3278 terminal and an IBM Personal Computer, you only need to purchase the attachment option to hook the two together.

IBM is making swift strides to integrate all of its lines of computers and bring the IBM Personal Computers into the corporate fold.—**Bruce Roberts**

Clubs and Newsletters

News from Budapest, Hungary

Members of a Hungarian home computer club meet to develop low-cost systems, lecture on computer techniques, and assist beginners with construction projects. Club members exhibit homebrew computers, programs, and peripherals at microcomputer symposiums held each year in Budapest, Hungary. For details, write to Dr. Endre Simonyi, 19 Trencsenyi, Budapest H-1125, Hungary.

Take the Buss

Buss, the Independent Newsletter of Heath Company Computers, contains tips, new programs, and news updates for Heath/Zenith owners. Each issue is numbered and has a table of contents for quick reference. A single issue is $2, a year's subscription (12 issues) costs $20, and an overseas subscription is $25. For more information, write to *Buss,* 716 E St. SE, Washington, DC 20003, or call (202) 544-0900.

Electronic Opportunity

Each monthly issue of the *Micro Moonlighter Newsletter* contains features on how to profit from home-based businesses using personal computers. An annual subscription is $25 in the U.S. and $29 in Canada. For details, write to the *Micro Moonlighter Newsletter,* 2115 Bernard Ave., Nashville, TN 37212.

Telecommunications in Engineering

The monthly newsletter produced by M/A-COM contains news and updates of recent developments in telecommunications engineering. For more information, write to M/A-COM DCC Inc., 11717 Exploration Lane, Germantown, MD 20874.

Design and Manufacturing

CAD/CAM Alert is a monthly newsletter containing news, checklists, reviews, and recommendations in the computer-aided design and manufacturing field. A one-year subscription is $95. Sample issues are available on request. For further information, write to *CAD/CAM Alert,* POB 404, Newton, MA 02161.

Help Yourself

Hi-Tek Connection is a monthly newsletter covering microcomputer systems and their applications. It is specifically written in easy-to-understand language. The *HTC* costs $40 a year with a 90-day money-back guarantee. For more information, write to Russell E. Marano, Hi-Tek Publications, POB 99, North Salem, NH 03073.

Memorable Optics

Optical Memory Newsletter including Interactive Videodisks is a bimonthly publication that features book and software reviews, articles, and a conference calendar. A one-year subscription (six issues) is $295. Discounts are available with multiple subscriptions. For details, write to *Optical Memory Newsletter,* POB 14817, San Francisco, CA 94114, or call (415) 621-6620.

Pruning the Family Tree

Genealogical Computing, a bimonthly periodical produced by Data Transfer Associates Inc., specializes in hardware and software applications to lineage research. It also contains news, reviews, programs, and services. Subscriptions are $14 a year in the *U.S.; Canadian* and foreign subscribers pay $19. For further information, write to Data Transfer Associates Inc., 5102 Pommeroy Dr., Fairfax, VA 22032.

Notes from North Star

North Star Notes is a newsletter designed to keep users of North Star Computers informed about the latest developments in hardware, software, and corporate activities. *North Star Notes* is free to anyone who wants to be on the mailing list. Send your requests to North Star Computers Inc., 14440 Catalina St., San Leandro, CA 94577, or call (415) 357-8500.

Spread the Word

The Spreadcalc News contains listings, applications, reviews, and news releases about getting the most from your Visicalc investments. The annual subscription rate is $25 (six issues). For details, write to Spreadsoft, POB 192, Clinton, MD 20735, or call (301) 856-1180.

In Terre Haute

The Wabash Valley Computer Society meets every fourth Wednesday of the month at 7 p.m. at the Vigo County Public Library in Terre Haute, Indiana. Family dues are $10 a year and include a subscription to the *Journal of the Wabash Valley Computer Society.* Contact the Wabash Valley Computer Society, 203 Briarwood Dr., Terre Haute, IN 47803, or call (812) 877-3269.

TRS-80 Color Computer Club

A TRS-80 Color Computer club in Durham, North Carolina, is welcoming new members. The club produces a monthly newsletter that contains features on the Color Computer. Membership is $10 and the newsletter is 85 cents. For more details, write to Donald DeHart, 3632 Cheek Rd., Durham, NC 27704.

LNW Information from Nebraska

The LNW User, a bimonthly newsletter for LNW-80 enthusiasts, is produced by the LNW User Group and contains programming news, hardware and software reviews, and a question-and-answer section. Subscriptions are $12 a year and back issues are available. For further information, write to *The LNW User*, 4345 Manchester Rd., Grand Island, NE 68801.

Central Ohio Amateurs Meet

The Amateur Computer Society of Central Ohio (ACSCO) meets on the first Wednesday of each month at 7:30 p.m. at the Barnett Rec. Center in Columbus, Ohio. Membership dues are $10 a year and include a subscription to the newsletter, the *I/O.* To swap newsletters, send yours to TRS-80—ACSCO, c/o Cramer, POB 28355, Columbus, OH 43228. For additional information about the club's activities, write to Joel Sampson, 3009 Calvmet, Columbus, OH 43202, or call (614) 262-2995.

Winnipeg PET Users Group

The Winnipeg PET Users Group (WPUG) meets on the first Wednesday of every month to exchange news about Commodore computers. Meetings include hardware and software demonstrations, speakers, and question-and-answer sessions. The $15 membership fee entitles you to receive the WPUG newsletter and provides access to more than 3000 programs in the WPUG disk library. For more information, write to Larry Neufeld, WPUG, 9-300 Enniskillen Ave., Winnipeg, Manitoba R2V 0H9, Canada.

File From Canada

File, a newsletter that examines ideas, processes, and technology in the publishing and direct-mail marketing industries, is produced six times a year by Creative Data Processing of Brauch & Neville Associates Ltd. For further information, contact Brauch & Neville Associates Ltd., 3390 Midland Ave., POB 351, Agincourt Post Office, Scarborough, Ontario M1S 3B9, Canada. ■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

BYTE's Bits

Porsche Will Go to Contest Winner

Seeq Technology of San Jose, California, will award a 1983 Porsche 944 to the person who comes up with the best application for one of its electrically erasable read-only memory (EEROM) chips. This chip, the 16K-bit 5-volt 5213, can be purchased for $9.95 at Schweber Electronics stores with a limit of two to a customer until May 31. Possible applications include a remotely programmable private branch exchange (PBX) for telephone systems or even jukeboxes that tell you when to replace worn records.

To be eligible, you must come up with a good idea, build it, test it, and send the schematic to Seeq by May 31, 1983. Complete rules and entry forms are available from local Schweber Electronics stores or from Seeq Technology, 1849 Fortune Dr., San Jose, CA 95131, (408) 942-1990.

North American Book Distributor

In Dr. Michael Carter's review of *Personal Documentation for Professionals,* the North American distributor of the book was not mentioned. (See the October 1982 BYTE, page 385.) It can be ordered from Elsevier Science Publishing Co., 52 Vanderbilt Ave., New York, NY 10017. ■



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Quentin Research

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USI

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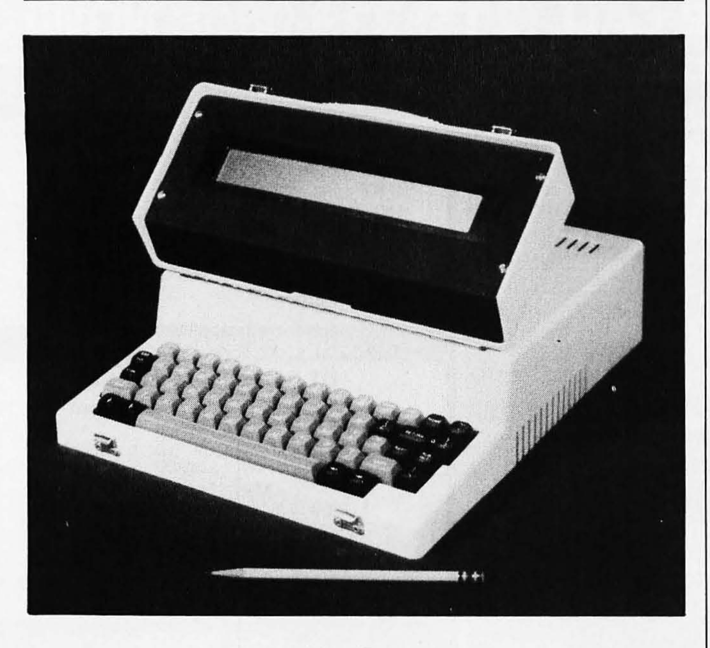


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What's New?

ELECTRONIC OFFICE



Portable Computer with Networking Potential

Up to 15 battery-powered Athena 1 portable computers can be connected in a local-area network. This 15-pound machine carries 512K bytes of solid-state storage, dual low-power NSC-800 processors running CP/M, 64K bytes of main memory for computation, 4K bytes of communications memory, and a full-sized keyboard. Its 4-line by 80-character display performs as a window because it's backed by 24 lines of 80 characters held in memory. A 5¼-inch floppy-disk drive, two RS-232C ports, and a printer port are standard. Expansion capabilities include up to 1 megabyte of internal memory and space for two additional circuit boards.

Athena 1 costs $3950. Address inquiries to Athena Computer & Electronic Systems, 31952 Camino Capistrano, San Juan Capistrano, CA 92675, (714) 661-2276.

Circle 600 on inquiry card.

DMS-15 Can Serve as Master Station

The DMS-15 can serve as a master in a Hinet local-area network. Hinet can support up to 32 users and address as many as 255. Manufactured by Digital Microsystems, and said to be an enhanced version of the portable Fox, DMS-15 comes with CP/M 2.0 and 15 megabytes of built-in Winchester-disk storage (formatted). It features DSC-3 (Z80A) architecture, 64K bytes of RAM (random-access read/write memory), a 9-inch display, one double-sided double-density 5¼-inch floppy-disk drive (614K bytes), a Hinet interface, and four RS-232C serial ports.

A list price of $7495 has been set for the DMS-15. The software to run the system as the Hinet master station costs $500. Quantity discounts are offered. Contact Digital Microsystems, 1755 Embarcadero, Oakland, CA 94606, (415) 532-3686.

Circle 601 on inquiry card.

Three Systems Support 5-11 Users

The C5002A, C8002A, and the Sundance 16 are 16-bit microcomputers that can support 5 to 11 users. Onyx Systems reports that each machine runs Unix System III. They will be marketed through OEMs (original equipment manufacturers), ISOs (independent sales organizations), and systems integrators.

An integrated computer/workstation, the Sundance 16 is available with VT100-type 132- or 80-column displays. Its 5¼-inch Winchester hard-disk storage capacities range from 7 to 21 megabytes, and 256K or 512K bytes of user memory with 12 megabytes of tape backup storage are offered. Retail prices begin at $12,990.

The C5002A supports five users or devices with its five serial and one parallel port. Options include 512K bytes of additional RAM (random-access read/write memory), six more ports for users or devices, and the Omninet network. Prices start at $10,990.

Using its internal upgradable option for local networking, the C8002A can support 11 users or devices. Mass storage is provided by 8-inch Winchester drives with 20-, 40-, or 60-megabyte capacities. Other features include 12 megabytes of tape backup and 256K or 512K bytes of RAM. The Omninet network is available as an option. The base price is $13,990.

For full details, contact Onyx Systems Inc., 25 East Trimble Rd., San Jose, CA 95131, (408) 946-6330.

Circle 602 on inquiry card.

Network to Connect Dissimilar Hosts

Tri-Data's Netway Family is designed to create a cohesive network using a variety of hosts and workstations, regardless of the local or remote protocols employed. The family comprises distributed-communications-oriented hardware and a multitasking/multiprogramming network DOS, called NCOS.

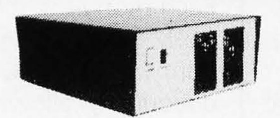
NNET networking software provides automatic alternative routing, online configuration from any workstation, and the ability to manage up to 254 processors. The NCOS operating system gives network and host transparency and has a user-friendly interface with help messages. It allows CP/M Plus to run as a task for applications development.

Retail Showroom
1780 West 2300 South
Salt Lake City, Utah 84119

The Great Salt Lake Computer Company, Inc.

Mail Orders
P.O. Box 26816
Salt Lake City, Utah 84126

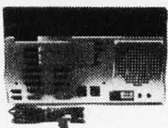
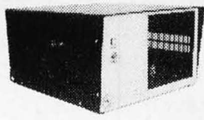
QT 5¼" MAINFRAME



• Provisions for any 2 - 5¼" drives • 15 ea DB 25 cutout • 2 ea 50 pin • 2 ea 34 pin • 1 ea Centronic • EMI filter (fused) • 2 AC outlets • Avbl. with 6 - 8 or 12 slot motherbd • Power supply (+8V16A/±16V3A/+12V5A)

QTC-MF+MD8 (8 slot MB) $720.00
QTC-MF+MD12 (12 slot MB) $765.00

QT 8" MAINFRAME

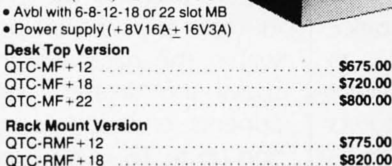



• Provision for any 2 - 8" drives (hard or floppy) • 15 ea DB 25 cutout • 2 ea 50 pin • 2 ea 34 pin • 1 ea Centronic • EMI filter (fused) • 2 AC outlets • Avbl with 6 - 8 or 12 slot motherbd • Power supply (+8V16A/±16V3A/+5V6A/−5V1A/+24V6A)

Desk Top Version
QTC-MF+DD8 .... $800.00
QTC-MF+DD12 .... $850.00

Rack Mount Version
QTC-RMF-DD8 .... $900.00
QTC-RMF-DD12 .... $950.00

QT STANDARD MAINFRAME

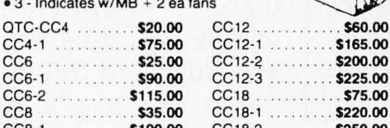


• Provisions for any 2 - 5¼" drives
• 15 ea DB 25 cutout • 2 ea 50 pin
• 2 ea 34 pin • 1 ea Centronic
• EMI filter (fused) • 2 AC outlets
• Avbl with 6-8-12-18 or 22 slot MB
• Power supply (+8V16A±16V3A)

Desk Top Version
QTC-MF+12 .... $675.00
QTC-MF+18 .... $720.00
QTC-MF+22 .... $800.00

Rack Mount Version
QTC-RMF+12 .... $775.00
QTC-RMF+18 .... $820.00
QTC-RMF+22 .... $900.00

QT S-100 CARD CAGES



• Made of anodized steel • Card guides for ea. MB • 1 - Indicates w/MB
• 2 - Indicates w/MB + 1 ea fan
• 3 - Indicates w/MB + 2 ea fans

QTC-CC4	$20.00	CC12	$60.00
CC4-1	$75.00	CC12-1	$165.00
CC6	$25.00	CC12-2	$200.00
CC6-1	$90.00	CC12-3	$225.00
CC6-2	$115.00	CC18	$75.00
CC8	$35.00	CC18-1	$220.00
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• Silence Plus • Built in Termination • IEE696 • Terminal strip for easy power connection

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QTC-MB4A $45.00

6 Slot Motherboards
QTC-MB6BB $30.00
QTC-MB6K $50.00
QTC-MB6A $65.00

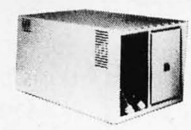
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22 Slot Motherboards
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QTC-MB22K $150.00
QTC-MB22A $200.00

QT 8" THINLINE MAINFRAME

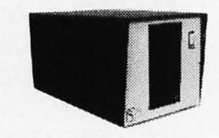


• Provisions for 2 ea 8" thinline drives • 15 ea DB 25 cutout • 2 ea 50 pin • 2 ea 34 pin • 1 ea Centronic • EMI filter (fused) • 2 AC outlets • Power supply (+8V16A/−5V1A/+24V6A)

Cadillac Version
QTC-IMF+DD6C (6 slot MB) $500.00

Ford Version
QTC-IMF+DD6F $389.00

QT DISK DRIVE CABINETS




"All in One" Vertical Disk Drive Cabinet

For 1) 2 ea or 4 ea 8" thinline drive
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• Power supply (+5V6A/−5V1A/+24V6A)
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• Power interface cable for any 8" drive

QTC-DDC88V *For 2 standard size 8" drives* $325.00
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QTC-DDC8V *For 1 ea 8" drive* $275.00

Horizontal Disk Drive Cabinet

For 2 ea 8" standard size drives
• Power supply (+5V6A/−5V1A/+24V6A)
• Interface cable for any 8" drive

QTC-DDC88H $300.00

DISK DRIVES

8" Disk Drives
801R Shugart SS/DD $355.00
851R Shugart DS/DD $455.00
DT8 (842) Oume DS/DD $465.00
BEST BUY M-2894-63 MIT DS/DD .... $409.00 *(call for qty price)*
M-2896-63 MIT 8" thinline DS/DD $475.00

5¼" Disk Drives
TM100-1 or B-51 for IBM $200.00
TM100-2 or B-52 for IBM $270.00

QT DISK DRIVE SUB ASSEMBLY

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5"h × 17"w × 20"d

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QTC-DDS+1 *w/1 ea DS/DD MIT 2894-63* $695.00
QTC-DDS+2 *w/2 ea DS/DD MIT 2894-63* $1150.00
QTC-DDS+3 *w/2 ea SS/DD 801R Shugart* $975.00
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Best Bare Board Set Available
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QTC-Z+80 BB $28.00
Teletek FDC-I A+T $595.00
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QTC-EXP+III 64K A+T $450.00

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I/O

QTC-I/O+BB *2 SER 3 PAR* $60.00
QTC-I/O + A+T $340.00
QTC-ADA *ADA Converter* A+T $375.00
QTC-Dual GPIB-488 *IEEE 488 Interface bd.* A+T $475.00

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5¼" soft sector (for Apple) .... $17.00 for 10
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Circle 210 on inquiry card.

NCOS is standard; NNET costs $500.

Netway hardware is built around the Netway 200 communications processor. It supports up to 32 workstations and host ports and renders remote and local networking facilities. System architecture includes multiple-DMA, an 800K-byte floppy-disk drive, a Centronics parallel printer port, and six serial I/O ports that support asynchronous, bisynchronous, and bit-oriented protocols. The single-unit price is $6880. Integrated 10- or 15-megabyte Winchester drives are available.

Additional hardware elements include a Z80-based device-interface processor with 64K bytes of memory and a local network interface, composed of a shielded cable and an RJ-11 connector. Prices range from $200 to $420.

A host of other hardware and interface modules are available as options. For details on possible configurations, contact Tri-Data, 505 East Middlefield Rd., Mountain View, CA . 94043, (415) 969-3700.

Circle 603 on inquiry card.

CDI Creates Office Systems Environments

Computer Development Inc. (CDI) will design and support an office communications system to your specific needs. Major components of CDI's modular approach to electronic communications include the Electronic Telecommunications (ET) System 3000 family of portable microcomputers and the Voice Com software package.

The System 3000 has a built-in microprocessor-controlled modem that comes with full communications software, software-controlled answer/originate modes, Touch-Tone and rotary-pulse auto-dialers, variable 300- to 1200-bps (bit-per-second) data rates, half-and full-duplex operation, interactive vocal and data communications abilities, and an error detection/correction protocol that automatically detects and corrects mistakes occurring during transmission.

Unlimited voice and data communications over ordinary telephone lines are achieved by Voice Com, which features single-keystroke operation and permits a document to be created, discussed, and edited simultaneously on all terminals online. It's part of the Commail electronic mail system. Commail also includes a communications system management program and a call handler/telephone link controller.

Basic ET System 3000 hardware is made up of dual Z80 processors, 64K bytes of RAM (random-access read/write memory), a 12-inch nonglare green-phosphor display, and a 72-key keyboard with a separate numeric/cursor control pad and 8 user-programmable function keys. Built-in diagnostics, CP/M, and a Help key are supplied. Software includes BASIC, COBOL, Supercalc, and applications packages.

Many options can be connected to the System 3000, including intelligent modems, mathematics and high-speed processors, and floppy- and hard-disk drives. For complete details on available systems and services, contact, CDI, Suite 200, 6700 Southwest 105th, Beaverton, OR 97005, (800) 547-1831; in Oregon, (503) 646-1599.

Circle 604 on inquiry card.

Integrated Office System

IOAS (integrated office automation system) is an integrated set of software modules for computers running MS-DOS, such as the IBM Personal Computer. Produced by Micro Architect, the IOAS line comprises a database manager, an applications system, and a word processor with a full-screen editor. Among the modules is the Exec-I executive information system. It's made up of seven applications: appointment, stock security, mailing list, check writer, personal finance, personal inventory, and memo. A graphics module and a spreadsheet interface are planned.

The IOAS system requires a dual-disk or a hard-disk system, monochrome display, 64K bytes of memory (94K bytes for the word processor), and a 132-column printer. Each module is sold separately, and prices range from $98 to $398. A 25% discount is allowed after the first module is purchased. For ordering information, contact Micro Architect Inc., 96 Dothan St., Arlington, MA 02174, (617) 643-4713.

Circle 605 on inquiry card.

Database System Has Unique Zoom Function

Powerbase is an easy-to-use relational database management system from GMS Systems Inc. Powerbase has a unique Zoom feature that lets you zero in on any information within the database and show the detailed components of that information up to 16 levels deep. Designed for IBM Personal Computers running PC-DOS, Powerbase offers a fast search, sort, and select feature, user-defined screens for data entry, user-specified reports, special keys for "sounds like" retrieval, a front-end editor, and the ability to handle arithmetic expressions written in algebraic form. As many as 65,000 records of 1760 bytes each can be accommodated, and each record can hold up to 32 fields of 80 characters. All files are random access by means of B-tree structure.

This system comes with daily planner, financial/insurance record inventory,

expense reporting, and telephone/mailing list directory applications programs. It requires 128K bytes of memory, PC-DOS, two 160K-byte floppy-disk drives or a hard disk, a cursor-addressable terminal, and an 80-column printer. It costs $475, including user and reference manuals. Contact GMS Systems Inc., 12 West 37th St., New York, NY 10018, (212) 947-3590.

Circle 606 on inquiry card.

Low-Cost Network

EXO Corporation reports that a fully functional network system can be achieved at a low cost with its Avalanche computer and EXO/Net, an enhanced version of CP/Net. The EXO system is a distributed network with sharing of disks, programs, databases, and printers, as well as full communications abilities. It supports up to 31 stations and one file server per channel. Individual computers in the network operate under CP/M when equipped with local disk storage. Stations are connected to a single twisted-pair cable up to 4000 feet long. The data rate is 800,000 bps (bits per second). Interfaces for other protocols to allow users access to mainframes and external databases are under development.

The file server runs the multitasking MP/M II operating system, which offers real-time capabilities and file protection with password access. Accounting, word processing, text editing, utilities, and electronic mail programs come standard.

The Avalanche is a single-board Z80A computer with 64K bytes of RAM (random-access read/write memory), RS-232C and RS-422A ports, and two parallel Centronics ports. It costs $595. A version with a floppy-disk controller for up to four 5¼- or 8-inch disk drives sells for $795. For $1795, the Avalanche can be purchased with a separate hard-disk controller board. These products are supplied with integral voltage regulators for OEM (original equipment manufacturer) applications. Contact EXO Corp., 1265 Montecito Ave., Mountain View, CA 94043, (415) 969-8624.

Circle 607 on inquiry card.

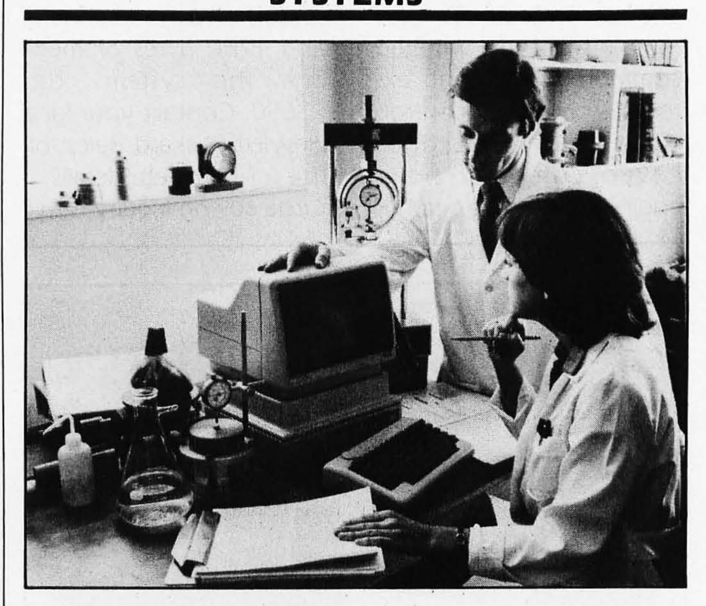
Apple Nets Local Network Scheme

Apple Computer plans to market the Applenet, which will electronically link Lisa and Apple II/III computers so that they can exchange information and share central files. Network connections will be a drop cable and a cluster box supporting up to four computers. For large networks, cluster boxes can be connected to a twin axial network cable capable of 1 million-bit-per-second transmission. Two thousand feet of cable can support up to 32 cluster boxes for a total of 128 systems.

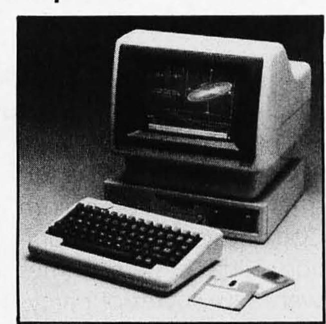
Applenet will employ baseband bus architecture with carrier-sense multiple access with collision detection (CSMA C/D) to avoid data loss during communication. All network components are located on an interface card that plugs into the computer. The Applenet, which will use the Xerox Network Systems (XNS) protocol, will be sold through Apple dealers and Apple's National Accounts program. For full details, contact Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014, (408) 973-3019.

Circle 608 on inquiry card.

SYSTEMS



HP's First 16-Bit Personal Computer



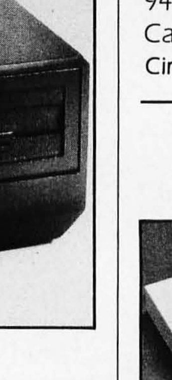
The HP Series 200 Model 16 is Hewlett-Packard's first 16-bit personal computer. The Model 16 will be sold through direct sales and retail computer stores. Based on the Motorola MC68000 microprocessor, the Model 16 offers an 8-MHz system clock and a choice of 3½-inch micro-floppy-disk drives. It has a 9-inch display, a detached ASCII keyboard, 128K bytes of main memory, graphics capabilities, and built-in parallel and serial interfaces. The video screen features an 80-character by 25-line display format with a resolution of 300 by 400 pixels. Its keyboard is outfitted with five user-

definable softkeys (ten with shift) and a rotary control knob for rapid program editing, cursor positioning, and analog control of instruments. The Model 16 can be linked in a network that shares disk drives and printers.

Three languages are available for the Model 16: BASIC, HPL, and Pascal. HP BASIC includes such enhancements as subprograms, multidimensional arrays, unified I/O and mass storage, labeled common blocks, and external program control. Application packages cover computer-aided engineering tools, mathematics modules, and business aids. The company is investigating the possibility of offering Digital Research's CP/M operating system on the Model 16 and plans to provide its own version of the Unix operating system in the future.

Among the Model 16 options are a tilt-and-swivel display accessory and a dual micro-floppy drive. Including the processor, display, keyboard, and 128K bytes of memory, this system costs $3650. Contact your local Hewlett-Packard sales office for complete details.

Circle 609 on inquiry card.



68000 Unix-based System Uses Multibus Architecture

The Codata 3300 is an MC68000 Unix-based microcomputer from Codata Systems Corporation. This system comes with 320K bytes of parity-protected RAM (random-access read/write memory), expandable to 1.5 megabytes with memory management. Its Multibus architecture supports a variety of mass-storage configurations. Backup data storage is available through quad-density floppy disks, cartridge tape, or 9-track tape drives.

All the software and programming languages developed for the Codata CTW-300 computer are fully compatible with the 3300. These include APL.68000, a BASIC-Plus-compatible interpreter, and Unisis, Codata's Unix superset. Standard implementations of FORTRAN 77, RM/COBOL, Pascal, and SMC BASIC are supported. Business applications software to run with the 3300 includes a database-management system, an electronic spreadsheet, and word-processing packages.

The standard eight-user 3300 comes with an integral 5¼-inch 33-megabyte Winchester hard-disk drive and lists for $9600. A two-user version with 12 megabytes of Winchester storage costs $7800. For multitasking, multiuser applications, the Codata 3300 can be purchased with an 8-inch 84-megabyte Winchester drive for $13,500. Contact Codata Systems Corp., 285 North Wolfe Rd., Sunnyvale, CA 94086, (800) 521-6543; in California, (800) 221-2265.

Circle 610 on inquiry card.



16-Bit Computer Costs Less Than $100

The TI-99/2 Basic Computer from Texas Instruments may be the first 16-bit computer for less than $100. Targeted at the technical enthusiast, engineer, and student, the TI-99/2 has a standard typewriter-like keyboard, 4.2K bytes of RAM (random-access read/write memory) that can be expanded to 36.2K bytes, a built-in RF (radio frequency) modulator, and monochrome display capabilities. For expansion, this system is equipped with a rear-panel peripheral interface connector for a variety of units especially designed for it, including an RS-232C interface, a digital tape drive, and a four-color printer/plotter. Later this year, Texas Instruments plans to release other peripherals, such as modems, printers, a wand input device, and a black-and-white monitor.

The TI-99/2 uses software on solid-state cartridges and cassettes. Initially, two cartridges are available: "Learn to Program" and "Learn to Program BASIC." In addition, 20 cassette-based programs covering education, personal management, and entertainment are scheduled for introduction this quarter. The suggested retail price of each cartridge is $19.95, and most cassette-based programs cost $9.95.

The TI-99/2 comes with a video cable and antenna switch for connection to any television, an interface cable that hooks directly to a cassette-tape player, an AC adapter, a user's manual, and a demonstration cassette. It costs $99.95. For details, contact Texas Instruments Inc., Consumer Relations Department, POB 10508, M/S 5828, Lubbock, TX 79408, (800) 858-4565.

Circle 611 on inquiry card.

What's New?

PERIPHERALS



Color Monitor with Headset for Privacy

A color monitor for personal and business computers featuring a nonglare screen, the Color-I Plus is manufactured by Amdek Corporation. The 13-inch Color-I Plus has a line resolution of 260 (horizontal) and 300 (vertical). It accepts a composite-video signal and comes with front compartment controls, a built-in audio amplifier, and a carrying handle. The Color-I Plus is supplied with a headset for private operation. The unit's speaker automatically shuts off when the headset is connected.

The Color-I Plus costs $449. For more information, contact Amdek Corp., Marketing Department, 2201 Lively Blvd., Elk Grove Village, IL 60007, (312) 364-1180.

Circle 612 on inquiry card.

Video Board Displays Uppercase/Lowercase in 80 by 25 Format

The 82-018 stand-alone video-terminal board from John Bell Engineering displays 80 columns by 25 lines of uppercase and lowercase characters. This video board uses a 6502 microprocessor and has RS-232C I/O lines for direct connection to a computer or modem. The 82-018 transfers data at rates ranging from 110 to 9600 bps (bits per second) through switch-selectable RS-232C lines. An onboard UART (universal asynchronous receiver/transmitter) is controlled by a five-position DIP (dual-inline pin) switch. Hardware features include 4K bytes of 6116-type RAM (random-access read/write memory), 2716 EPROMs (erasable programmable read-only memories) for character generation and video program control, a 6545-1 display controller, an interrupt-driven serial input port, and a 1500-character buffer. Power requirements are +5 V (volts) at 700 mA (milliamperes), +12 V at 50 mA, and −12 V at 50 mA.

The 82-018 requires a parallel ASCII keyboard, a standard NTSC (National Television Standard Code) monitor, and power supply. It can be purchased fully assembled and tested for $199.95 or as a bare board with EPROMs and crystal for $89.95. Shipping and handling fees are additional. Complete source listings are included in the documentation. Both versions are available directly from John Bell Engineering Inc., 1014 Center St., San Carlos, CA 94070, (415) 592-8411.

Circle 613 on inquiry card.

Hard Disk for APC

NEC Information Systems is marketing a 12-megabyte hard-disk subsystem for its Advanced Personal Computer. This high-performance 5¼-inch drive stores 9.27 megabytes of formatted data and transfers data at a rate of 500K bytes per second. Track-to-track head movement time is 120 ms (milliseconds) and the access time averages 130 ms. The rotation rate is 3000 revolutions per minute. This system's hardware features a direct-drive DC spindle motor, microprocessor controls, and LSI (large-scale integration) circuits. Mean time between failures is 12,000 power-on hours. It measures 6¼ inches high by 9⅞ inches wide by 15 inches deep.

The APC hard-disk subsystem costs $2798. The 16-bit APC computer is 8086-compatible and supports CP/M-86, MS-DOS, and the UCSD p-System. Address inquiries to NEC Information Systems Inc., 5 Militia Dr., Lexington, MA 02173, (617) 862-3120.

Circle 614 on inquiry card.

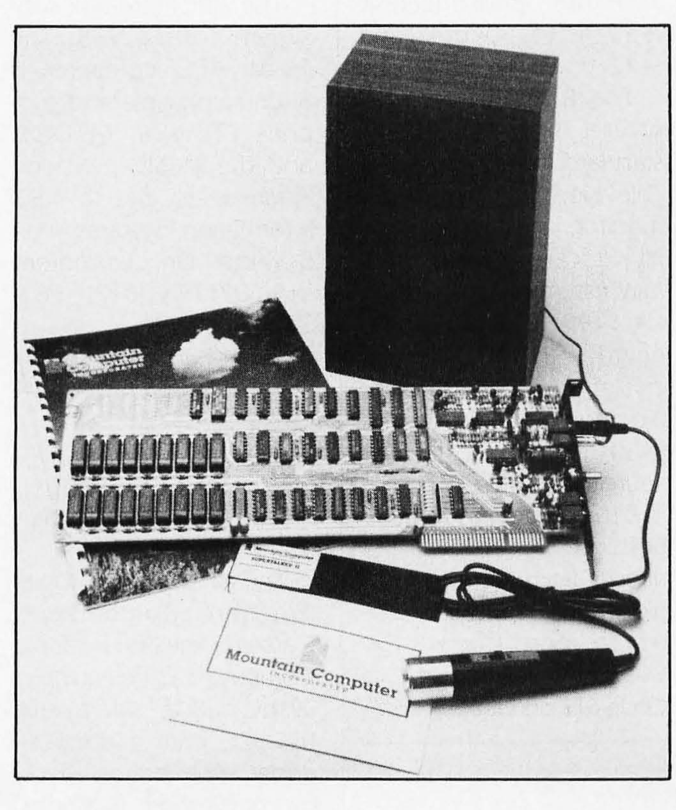
Combination Cards for IBM PC

The XPR Series of Multifunction Combination Cards for the IBM Personal Computer can be equipped with a parallel port, a serial RS-232C port, a clock/calendar with battery backup, or all three functions. The parallel port comes with required hardware and connectors for use as either a printer or as a SASI (Shugart Associates Standard Interface) hard-disk interface. The serial port, with a DB25 connector, can be used as COM1 or COM2. Both ports can be individually disabled. The clock/calendar option, coupled with its companion software, automatically provides current time and date information to the PC. The XPR comes on a single printed-circuit

board and with up to 256K bytes of memory.

The XPR is supplied with installation and reference manuals, internal cabling, connectors, mounting hardware, and a diagnostic disk. Prices range from $350 to $650 for one option and 64K to 256K bytes of memory. Your second option costs $45; the third is $30. Quantity and dealer discounts are available. Contact IDE Associates, 44 Mall Rd., Burlington, MA 01803, (617) 272-7360.

Circle 615 on inquiry card.



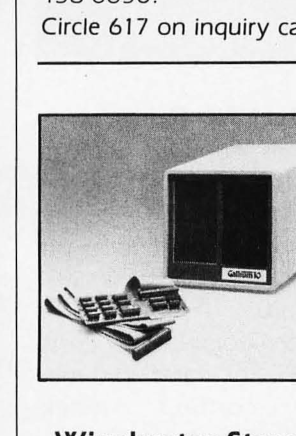
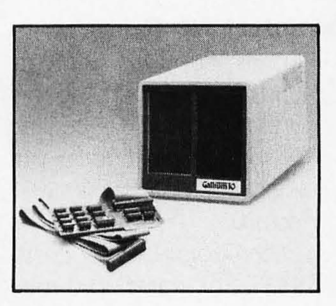
Supertalking IBM Personal Computers

Mountain Computer's Supertalker II gives your IBM Personal Computer a vocal outlet. Sound enters the Supertalker through a microphone and is then digitized and stored on a floppy disk for playback through a loudspeaker or the PC's speaker. This plug-in board is said to reproduce a human voice in a manner similar to an audio tape recorder, providing inflection not possible with voice synthesizers. A single floppy disk can record up to 2 minutes of phrases or sentences, and voice output can be accessed with Supertalker's software or by user-developed BASIC programs.

A data-compression technique minimizes disk-storage requirements. Three digitizing rates, ranging from 2K to 4K bytes per second, control the quality of reproduction, and the volume is controlled by software or with a built-in control knob. Frequency response is 300 to 3000 Hz.

Supertalker requires a 64K-byte IBM PC and a single disk drive. It comes with menu-driven software for creating and editing phrases, 32K bytes of RAM (random-access read/write memory), a loudspeaker, and a microphone. Supertalker II costs $565 and is available at Mountain Computer retail stores. Mountain Computer Inc. is located at 300 El Pueblo Rd., Scotts Valley, CA 95066, (408) 438-6650.

Circle 617 on inquiry card.

Winchester Storage for Apple and PC

Xiten Systems is offering an 11.3-megabyte Winchester-disk subsystem for Apple II/IIe and IBM Personal Computers through a select network of IBM and Apple dealers. The Gallium 10 stores 14.4 megabytes of unformatted data and can be partitioned for DOS 3.3, CP/M, and Pascal when used with Apple computers. For the PC, it can operate under PC-DOS or CP/M-86. Its cabinet and power supply can support two Winchester-disk drives (28.8 megabytes total storage), and its controller can handle four drives in two cabinets (57.6 megabytes total). For the location of the dealer nearest you, or for more information, contact Xiten Systems, 16815 Hawthorne Blvd., Lawndale, CA 90260, (213) 370-3966.

Circle 618 on inquiry card.

Voice-Response Unit with Modem

A low-speed modem now complements the single-board interactive voice-response unit for Apple II from Vynet Corporation. The basic element of the response unit, the V101-A Interactive Telephone Interface board, is designed to plug into an Apple peripheral slot and connect directly to the telephone network. It can answer on ring and dial and detect Touch-Tone signals. With this unit, users can call or be called by a computer and respond with Touch-Tone signals to computer inquiries for modifying program flow or updating the database, without terminals or dedicated lines. A set of 20 routines, resident in ROM (read-only memory), preprograms all functions to control interface hardware. Voice-response capabilities are provided by the V200-VSM (voice-synthesizer module). The V200-VSM, an LPC (linear-predictive coding) based unit, comes with a 300-word vocabulary on disk; a 1300-word option is available.

The modem option consists of the V103-A

motherboard and the V200-LSM (low-speed modem). The V103-A fastens into a slot on the Apple and is cable-connected to the V101-A. The V200-LSM provides 300-bps (bit-per-second), Bell 103-compatible half- or full-duplex data-communications abilities. In systems equipped with both the V200-VSM and the V200-LSM, the V101-A permits voice and data communications to share a single telephone line.

System software comes in Applesoft, Pascal, or CP/M formats. The V101-A costs $295, and the V103-A is $19.95. Both the V200-VSM and the V200-LSM are $149. Contact Vynet Corp., 160B Albright Way, Los Gatos, CA 95030, (408) 370-0555. For an online demonstration, call (800) 538-7002 or (408) 370-9764.

Circle 619 on inquiry card.

PUBLICATIONS

Timex/Sinclair Sourcebook

The **Timex/Sinclair Sourcebook** is a directory of more than 600 programs, hardware accessories, add-on memories, and books for Timex and Sinclair computers. Produced by Micro Design Concepts, the **Sourcebook** lists and describes mail-order products from almost 160 sources. Each listing provides such facts as program highlights, type of media, minimum system configuration, price, and ordering information. The entries are organized by category: games, education, business, home/personal use, hardware, and books/catalog.

The 96-page **Timex/Sinclair Sourcebook** costs $6.95, plus $1.25 postage and handling; $2.50 postage and handling outside the U. S. It's available from Micro Design Concepts, Department F, POB 280, Carrollton, TX 75006.

Circle 620 on inquiry card.

Report Studies Electronic Typewriters

Seybold Publications has released a comparative study entitled **Electronic Typewriters: Getting Started for Less Than $2000**. This analysis of the major products on the electronic typewriter market covers such manufacturers as IBM, Xerox, Exxon, Olivetti, Olympia, and Royal. A discussion of the role of the electronic typewriter in the automated office, a summary of functions available, a glossary of terms, and a comparison chart of model features are included.

For subscribers of the **Seybold Report on Office Systems**, this report costs $75; nonsubscribers pay $100. Order it directly from Seybold Publications Inc., POB 644, Media, PA 19063, (215) 565-2480.

Circle 621 on inquiry card.

Directory Covers Products for IBM

The Directory of Independent IBM Personal Computer Hardware and Software from Infopro is a comprehensive buyer's guide of software and hardware developed for the IBM Personal Computer. It contains descriptions and evaluations of more than 400 products and provides the addresses and telephone numbers of all the vendors profiled. All the software in the directory runs under the PC-DOS operating system.

This directory costs $29.95. It's available at participating dealers or directly from Infopro Inc., POB 22, Bensalem, PA 19020, (215) 750-1023.

Circle 622 on inquiry card.

Win at Home Video Games

How to Win at Home Video Games analyzes 70 home-video games step by step so that you can develop game-winning strategies. It covers such games as Adventure, Donkey Kong, and Utopia designed for Atari, Intellivision, Odyssey 2, and Colecovision game systems. Descriptions and buying guide information are included.

This 4-color, 64-page book by the editors of **Consumer Guide** magazine costs $3.98. It's published by Beekman House and distributed by Crown Publishers, One Park Ave., New York, NY 10016.

Circle 644 on inquiry card.

Guide Spans Databases

The current edition of the **Directory of Online Information Resources** covers more than 720 databases up and running in North America. This guide has subject, vendor, and producer indices, address and telephone information for all database producers and vendors, and database price information. It's completely revised semiannually.

Single copies of the directory costs $22.50, plus $1.50 postage and handling. A subscription price of $60 (four issues) is available. To order, contact the CSG Press, 11301 Rockville Pike, Kensington, MD 20895, (301) 881-9400.

Circle 623 on inquiry card.

SOFTWARE

Suspended Joins Interlogic Line

Infocom has announced Suspended, the sixth game in the Interlogic product line. Suspended joins such adventure games as Deadline, Starcross, and the Zork trilogy. Interlogic games are highly interactive and feature a programming language that permits complete sentence communication between player and computer. The games run on virtually any computer, including DEC Rainbow, TI Professional Computers, Osborne 1, NEC APC, and 8-inch CP/M-based systems.

In Suspended, you and your six robot assistants must rescue the population of a planet deep in outer space. While in a limited state of cryogenic suspension, you must repair damage on the planet with your robots. The robots, which can act for you independently of one another, can be sent to different locations and make subsequent moves. Suspended is the first Interlogic game to have a functional game board with movable pieces. Estimated playing time is 30 hours.

Suspended, which was released early last month, is the brainchild of Michael Berlyn. It costs $49.95 and is marketed through software distributors, major retail stores, and personal-computer manufacturers. Infocom Inc. has its headquarters at 55 Wheeler St., Cambridge, MA 02138, (617) 492-1031.

Circle 624 on inquiry card.

Commodore 64 Accounting System

Info-Designs has reprogrammed its Management Accounting System for the Commodore 64 computer. Currently, five modules are available: Accounts Receivable/Billing, Accounts Payable/Checkwriting, General Ledger, Inventory Control, and Payroll. These programs work with one or two Commodore 1541 single-disk drives and a matrix printer. They cost $199 each and are marketed through more than 600 Commodore dealers nationwide. An electronic staff-scheduling and appointment handler program, called the Electronic Calendar, will be available in June. For full dealer and end-user information, contact your local Commodore regional office or Info-Designs Inc., 6905 Telegraph Rd., Birmingham, MI 48010, (313) 540-4010.

Circle 625 on inquiry card.

Access 8086 Development Software

Genesis Microsystems' Access lets you run Intel Series-III 8086 development software on your Compaq or IBM Personal Computer at a substantial cost savings. A version for systems running CP/M-86 is also available. With Access, your computer can run such software as PL/M-86, FORTRAN-86, and Pascal-86. Access provides you with an operating system adapter program and a data link program for transferring files between your computer and Intel Series-II/III systems. A program that connects your computer to Intel's 957A debugger for downloading programs to your system is also available. It costs $450.

For a complete 8086 development system, the manufacturer recommends a 128K-byte computer with MS-DOS, two 320K-byte floppy-disk drives (or a hard disk), a monochrome display, and a text editor. Access costs $950 and can be ordered directly from the manufacturer. For benchmark and price comparisons, contact Genesis Microsystems, POB 70280, Sunnyvale, CA 94086, (408) 241-3727.

Circle 626 on inquiry card.

High-Quality Text Processor

The print quality of the Incredible Text Printer (ITP) from Datamed Research is said to be equivalent to the best stand-alone word processors and to exceed that of any other text processor. ITP has extensive, built-in automatic text-formatting capabilities and a series of menus to help you set up printing formats. Among its text-formatting options are underlining, boldface, subscript, superscript, variable character widths, tab and line drawing, and table and figure relocation. ITP automatically hyphenates words at the end of the line, creates indexes and tables of contents, and numbers sections, tables, and figures. It gives you extensive control over headings, subheadings, and footers, including centered and left and right justified fields. With this system, you can insert files from within other files, add pages, and generate personalized form letters or customized text from name and address files or entered from the console. Other features include run-time entry of text or instructions from the console.

ITP runs on UCSD Pascal-compatible systems. It requires 56K bytes of memory, two floppy-disk drives or a hard disk, an external text editor, and a 24-line by 80-character display monitor. It costs $249, which includes six months of free updates. A demonstration disk can be purchased for $60, and the manual alone is $30. Dealer terms are available. Datamed Research Inc. is located at 1433 Roscomare Rd., Los Angeles, CA 90077, (213) 472-8825.

Circle 627 on inquiry card.

User-Friendly Spreadsheet

The Timberline Spreadsheet is said to be a user-friendly system designed for small businesses with no prior computer experience. Timberline features an array of statistical calculation capabilities and six conditional statements for developing reports based on changing financial parameters. Conditional statements allow almost any set of conditions to be entered into the spreadsheet in an If . . . Then format. While it offers traditional financial calculations, Timberline is also flexible enough to calculate such equations as net present value and internal rate of return. Statistical calculations include linear regression, correlation coefficients, dependent vari-

able, analysis independent variable, and standard deviation.

The Timberline Spreadsheet's double-window display lets you view separate areas on the worksheet. Its editing function, based on user-definable commands, permits rows and columns to be inserted, deleted, or moved. Rows can also be sorted by alphabetic or numeric information, and blocks of data can be moved.

This package will run on computers using the UCSD p-System with a minimum of 64K bytes of memory and two floppy-disk drives. The Timberline Spreadsheet costs $395 and can be purchased factory-direct from Timberline Systems Inc., 10550 Southwest Allen Blvd., Beaverton, OR 97005, (503) 643-9461.

Circle 628 on inquiry card.

CP/M Graphics Conforms to GKS, VDI Standards

Digital Research designed CP/M Graphics architecture with standard interfaces at the programmer and device levels. The programmer interface conforms to the emerging ANSI and ISO Graphical Kernel System standard, which provides source-code portability. The device-level interface addresses ANSI VDI (Virtual Device Interface) to provide object code portability. The CP/M Graphics line is comprised of six products: GSX, GSS-4010, GSS-Kernel, GSS-Plot, GSS-Graph, and GSS-Draw.

GSX is required by all the packages in the line. It's the graphic system extension to the CP/M operating system. It provides graphic output through standard operating-system calls. Three components make up GSX: GDOS (Graphics Device Operating System), GIOS (Graphics Input/Output System), and the Gengraf utility, which configures a graphics application to run in the GSX environment.

Other programs let you use graphic software that currently exists only on mainframe computers, create portable graphics applications programs, produce programs for typical business, engineering, and scientific representations, and create and edit presentation-quality charts and diagrams. For complete details on the CP/M Graphics product line, contact Digital Research, POB 579, Pacific Grove, CA 93950, (408) 649-5500.

Circle 629 on inquiry card.

Speachware: Software with the Gift of Gab

Centigram Corporation and Peachtree Software have teamed up to produce a line of talking software, known as Speachware. This speech-synthesis system works with hardware devised by Centigram and with speech files created and edited by Peachtree Software, maker of the Peachpak 8 Accounting Series and other software packages. It's reported that this combination produces user-friendly software that's suitable for teaching people with limited computer knowledge how to process information. Speachware will provide voice capabilities to existing or forthcoming Peachtree software.

Centigram's Voiceware Development System is the hardware heart of Speachware. It offers bit rates averaging 3000 bps (bits per second), which reduces the amount of host computer overhead as well as the amount of mass storage needed to hold messages. Voiceware digitizes and compresses analog waves using a proprietary coding technique known as PWC (parametric waveform coding). Analyses of waveforms are done at variable-length intervals, with frame rates determined by the voiced or unvoiced events in the original speech. This results in a synthesized waveform that's nearly identical to the original. Voice output is achieved by means of Centigram's Sybil synthesizer board, which uses the General Instrument SPO250 chip. Sybil is compatible with the IBM Personal Computer.

For further details, contact Centigram Corp., 1153 Bordeaux Dr., Sunnyvale, CA 94086, (408) 734-3222.

Circle 630 on inquiry card.

OEM Applications Sought for Image-Recognition System

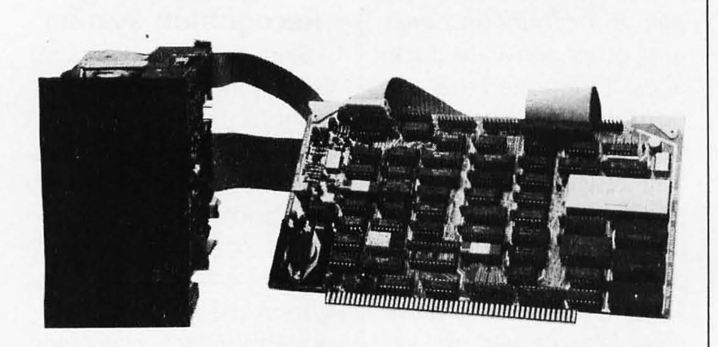
Sirius Software is seeking OEM (original equipment manufacturer) applications and will consider a variety of licensing agreements for its stand-alone, Multibus-based image-recognition system, called Floyd. This system uses a custom-designed video processor and an NSC 16032 central processor. The video processor demodulates and digitizes an incoming NTSC (National Television Standard Code) color signal, then it fills two 64K-byte memory planes 60 times a second. The central processor can access this memory continuously for real-time image analysis. Floyd's color resolution is 510 by 213 pixels through a 4-bit gray scale. Color is demodulated to red/yellow, blue/yellow format.

Floyd offers softswitch-selectable code conversions for linear, log, or inverse storage, and it has 8-bit color storage (256 colors) as red/yellow, blue/yellow vectors with softswitch-selected code conversion for hue correction. Video memory is 128K bytes, expandable to 256K bytes using 150-nanosecond RAMs (random-access read/write memories).

For complete technical specifications, contact Sirius Software, Research and Development Department, 10364 Rockingham Dr., Sacramento, CA 95827, (916) 366-1195.

Circle 631 on inquiry card.

MISCELLANEOUS



Hard-Disk Subsystem Has Error-Correcting Controller

Advanced Digital Corporation has unveiled a 5¼-inch Winchester hard-disk subsystem for S-100 microcomputers. This system is built around the company's HDC-1001 error-correcting hard-disk controller board, which features an onboard microprocessor, multiple burst detection, up to 9-bit single burst correction, and data rates approaching 5 megabytes per second. A built-in 32-bit computer-generated polynomial is said to be able to detect and correct errors before the user is even aware of them. The HDC-1001 can control up to four drives and as many as eight read/write heads and is IEEE 696 (S-100) compatible.

The Winchester subsystem comes with the HDC-1001 controller board, connector cable, CP/M BIOS disk, and drive mechanisms. It's available in 5-, 10-, 20-, and 40-megabyte versions. The 5-megabyte model uses Seagate Technology's ST506 drive, and the 10- and 20-megabyte units feature the miniscribe drive. Prices begin at $1800; quantity discounts are offered. Contact Advanced Digital Corp., 12700 B Knott Ave., Garden Grove, CA 92641, (714) 891-4004.

Circle 632 on inquiry card.

Tomorrowhouse Today

Tomorrowhouse is a turnkey home monitoring and control system from Compu-Home Systems. It's based on the Apple II computer and is made up of a plug-in circuit board, a junction box, hardware for hookups, all the programs needed to set up and control your house, and installation and user manuals.

Tomorrowhouse lets you schedule heating and cooling systems up to nine weeks in advance with as many as 48 changes per day. You can automate your lights, appliances, and hot tub for maximum energy conservation. Complex heating and cooling and light/appliance schedules for different circumstances can be stored and recalled for execution whenever necessary. Verbal warnings and an easy-to-read graphics display of your home's floorplan with status information presented both graphically and verbally are provided by Tomorrowhouse. Convenience features include an appointment calendar, a voice wake-up call, and a record-keeping system that tracks each time Tomorrowhouse is booted or an alarm detected.

Tomorrowhouse is available in kit form or dealers can provide turnkey installation. For individuals with Apple computers, kit prices start at less than $1000. For full details, contact Compu-Home Systems Inc., 3333 East Florida Ave., Denver, CO 80210, (303) 777-6600.

Circle 633 on inquiry card.

Computer Camps

The following is a list of computer camps and where to send for complete information.

Camp Compuquest, POB 8161, Lexington, KY 40533, (606) 278-9933.

Champlain College Computer Camp, Shelley Richardson, Room #4A, Box 670, 163 South Willard St., Burlington, VT 05402, (802) 658-0800.

Compu Camp, 7101 York Ave. S, Edina, MN 55435, (612) 835-0064.

Computer Camp, Registrar, J. Hamilton Welch Academy, 3049 McGregor Blvd., Fort Meyers, FL 33901, (813) 334-6044.

Computer Camp Inc., Suite G, 1235 Coast Village Rd., Santa Barbara, CA 93108, (800) 235-6965; in California, (805) 969-7871.

Computer Camps International, Suite D, 310 Hartford Turnpike, Vernon, CT 06066, (203) 871-9227.

Computer Experience, Performance Designs Inc., 1411 North Main St., POB 124, Bluffton, IN 46714, (219) 824-5120.

Family Computer Camp, Conference and Information Center, Clarkson College, Potsdam, NY 13676, (315) 268-6647.

Hockaday Computer Camp, 11600 Welch Rd., Dallas, TX 75229, (214) 363-6311.

Lake Forest Computer Camp, Lake Forest College, Sheridan and College Roads, Lake Forest, IL 60045, (312) 234-3100.

Long Acres Computer Camp, Route 1, Box 320, Spotsylvania, VA 22553, (703) 582-5382.

National Computer Camp, POB 585, Orange, CT 06477, (203) 795-9667.

Tar Heel Career Camps Inc., POB 2328, Chapel Hill, NC 27514, (919) 967-6996.

Timbertech Computer Camp, 1287 Lawrence Station Rd., Sunnyvale, CA 94086, (408) 745-1110.

Virginia Tech Computer Camp, Carisa Blaylock, College of Education, 400 War Memorial Gym, Virginia Tech, Blacksburg, VA 24061, (703) 382-2123.



Bulk Eraser Works Without Batteries, External Power

Nortronics' Model CMP-230 Computer Tape Bulk Eraser is a handheld unit with two strontium-ferrite magnets for quick erasures of standard-size cassette tapes. The magnets are divided into four quadrants of north and south poles and are positioned so that a cassette encounters 16 different flux fields as it passes through. This unit operates without batteries or external power supplies.

The Model CMP-230 Bulk Eraser has a $49.50 suggested retail price. It's manufactured by Nortronics Co. Inc., 8101 Tenth Ave. N, Minneapolis, MN 55427, (612) 545-0401.

Circle 634 on inquiry card.



Apple-Compatible Keyboard

The Model KB-200 detached keyboard is plug-compatible with the Apple II computer. Available directly from Key Tronic Corporation, the low-profile KB-200 has 83 keys, a combination cursor and standard numeric keypad, and an extra Return key for use as an Enter key. Cursor controls include diagonal movements. Eleven functions keys are provided for easy multiple-key functions, and a movable jumper causes the keyboard to output lowercase characters if the Apple is equipped to accept them. Standard features include sculptured, nonglare keytops with double-shot molded keys, full key travel with positive tactile feedback, N-key rollover, microprocessor electronics, solid-state capacitances, and a flexible cable.

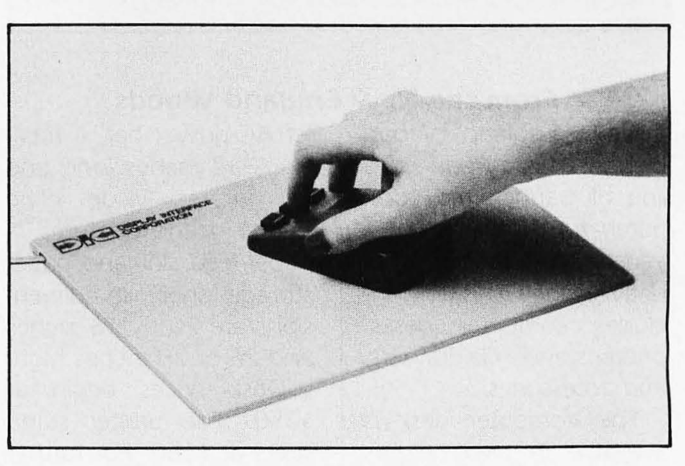
With postage, the Model KB-200 costs $298. Contact Key Tronic Corp., POB 14687, Spokane, WA 99214. For ordering information, call (800) 262-6006; in Washington state, or for technical information, call (509) 928-8000.

Circle 636 on inquiry card.

Tecmar Markets IBM PC Packages

Tecmar manufactures more than 60 peripherals and software packages for the IBM Personal Computer. Its hardware includes a high-speed, 5-megabyte removable-cartridge Winchester disk drive, a 15-megabyte Winchester system, high-resolution graphics, an Ethernet network interface, and a voice-recognition unit with a 100-word vocabulary. Tecmar's software includes such offerings as the Coherent DOS (a Unix look-alike with real-time extensions and multiuser, multitasking capabilities) and support packages for laboratory hardware, an IEEE-488 interface, and an EPROM (erasable programmable read-only memory) gang programmer. For information, contact Tecmar Inc., 23600 Mercantile Rd., Cleveland, OH 44122, (216) 464-7410.

Circle 635 on inquiry card.



Cursor-Positioning System Has Cordless Mouse

The Datawafer cursor-positioning system from Display Interface Corporation consists of an ultra-thin position detector and a cordless mouse. The mouse is powered by a self-contained recharge-

able battery and is available with 1, 3, 4, 12, or 16 keys for inserting instructions and data. The Datawafer, only 0.2 inch thick, detects and transmits position information any time the mouse is within 3 inches of its surface. It comes with passive position-detecting elements, or it's available with electronic circuitry for signal conversion and for interfacing with data-processing systems. The optional electronics package can be supplied as a separate plug-in card, or it can be mounted on the bottom of the Datawafer, increasing its thickness to 0.75 inches.

Cursor and stylus versions of the positioning device are being developed, each of which will be completely interchangeable with the mouse. Complete information can be obtained from Display Interface Corp., 525 Post Rd., Milford, CT 06460, (203) 877-7661.
Circle 637 on inquiry card.



From the New England Woods

New England Wood Designs has introduced a line of handcrafted computer furniture, all in a variety of hardwoods and native pine. This line includes computer desks, printer stands, file drawers, and accessories.

The computer desk is available in two heights (26 or 29 inches) and can accommodate a disk drive and a number of accessories. It has adjustable shelves and a multiple-outlet AC-power bar. It measures 42 inches long and 30 inches wide. The printer stand features a paper-feed slot and paper storage shelf. Its dimensions are 20 by 16 inches and 26 or 29 inches high.

Desk prices begin at $350. The printer stand starts at $160. For further information, contact New England Wood Designs, RFD 1, Box 53, Greenfield, NH 03047, (603) 924-7367.



Portable Gold-Plating System

A compact, portable gold-plating system suitable for quick and safe replating of edge connectors or gold-plated surfaces has been introduced by Pace Inc. The PEP-220 Gold-Plating System is a self-contained package that includes noncontaminating electrode assemblies, conductive and platers tape, power cord, case, tray, and gold-plating, electro-cleaning, and nickel-plating solutions. The unit comes with the PPS-76 power source, which provides precise DC outputs for each solution.

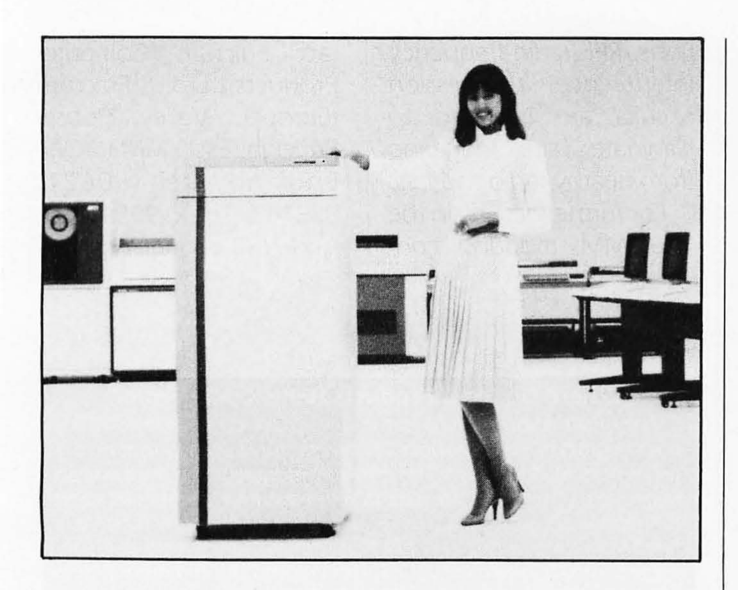
The PEP-220 is being marketed through Pace representatives. For further details, contact Pace Inc., 9893 Brewers Court, Laurel, MD 20707, (301) 490-9860.
Circle 638 on inquiry card.

FOREIGN

Bimonthly Lists Published Programs

The **Small Computer Program Index** is a bimonthly index of printed program listings from a wide range of United Kingdom and American magazines and books. Subjects covered include science, social science, business and management, education, games, home applications, text and word processing, mathematics, statistics, and utilities. Most of the programs are in BASIC but are said to be equally applicable to mainframe computers that support BASIC, FORTRAN, and ALGOL.

The 1983 subscription price is $45 (six issues and an index). For $72, you can enter a subscription for 1983 and receive all the 1982 back issues. **Small Computer Program Index** is produced by Allm Books, 21 Beechcroft Rd., Bushey, Hertfordshire WD2 2JU, England; tel: Watford (0923).
Circle 639 on inquiry card.



First 32-Bit Business Computer Unveiled

Mitsubishi Electric Corporation has announced the availability of the Model 500, Japan's first small-business computer using 32-bit architecture. System hardware includes 16 megabytes of logical space using a virtual storage-control system, a main-memory capacity of up to 8 megabytes, a magnetic disk drive capable of accommodating a large-capacity file of up to 4.8 gigbytes, and a 12-megabyte-per-second transfer time. Up to 128 terminals (64 inline workstations and 64 online circuits) can be connected to the Model 500. For office automation, the Model 500 has Japanese word processing and business graphics capabilities. When running the DPS 10 processing system and relational database, the Model 500 is said to have the performance of a medium-sized general-purpose computer. DPS 10 enables five-dimensional multiprocessing: workstation, timesharing, transaction, remote-batch processing, and local-batch processing. High-level language support includes Mitsubishi's Duet conversational user language, COBOL, and FORTRAN.

Options include an 8K-byte cache memory. For details, contact Mitsubishi Electric Corp., 2-3, Marunouchi 2-chome, Chiyoda-ku, Tokyo, 100 Japan; tel: Tokyo (218) 2171; Telex: J24532.

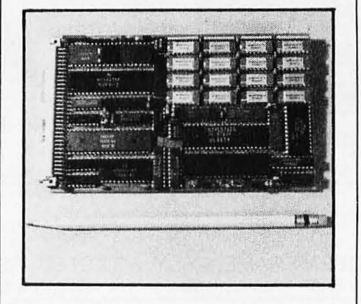
Circle 640 on inquiry card.

Survey Probes Users of Word Processors

The results of a recently conducted survey of 367 Canadian users of word-processing systems are available from Wordcom Centres Ltd. This survey examines the attitudes of operators, supervisors, and managers and their perceptions of the word-processing environment. The study begins by identifying the decision-makers and highlighting the reasons contributing to the final selection of equipment. It then evaluates training, cost savings, service response time, and efficiency gained from the installation. In addition, this survey offers comparisons of the most frequently mentioned manufacturers and strives to show common denominators and the indicated results of certain approaches to the selection of people and systems.

Copies of this survey cost $50 (Canadian). It's available from Wordcom Centres Ltd., Suite 100, 64 Shuter St., Toronto, Ontario M5B 2G7, Canada.

Circle 641 on inquiry card.



128K-Byte Computer Packed on Eurocard

The Quark/100 from Megatel is an 8-bit, 128K-byte CP/M-compatible computer packed onto a single Eurocard. Megatel based the Quark/100 on the 6-MHz Zilog Z80B processor and used three PAL (programmable array logic) circuits and gate-array technology to squeeze all memory, disk, display, and I/O functions onto a standard 100 mm by 160 mm Eurocard.

The Quark/100 has a dual-mode alphanumeric/graphic video-display interface with a software-programmable character set. The display operates in an 80-column by 28-line format that's backed by a bit-mapped graphics mode using 24K bytes of dedicated RAM (random-access read/write memory). You can connect the Quark/100 to any standard display with its direct-drive and composite video outputs, and it has inputs for encoded or wire-only keyboards. Standard features include single- and double-density 5¼- or 8-inch floppy-disk interfaces, full-duplex and simplex RS-232C serial ports, a parallel port for a printer, and 22 general-purpose I/O lines for applications flexibility. For special-purpose peripherals, access to the central processor's address, data, and control buses is provided.

The Quark/100 is $595 (U.S.). A complete package with a transistion board, connector, installation software, CP/M 2.2, and BIOS source listings costs $995. A version with a color video-display interface with red/green/blue video outputs can be ordered. A 1-megabit-per-second network interface can be added to the Quark/100. Contact Megatel Computer Corp. Inc., 150 Turbine Dr., Toronto, Ontario M9L 2S2, Canada, (416) 745-7214.

Circle 642 on inquiry card.

Energy-Management Module

An IEEE 696 (S-100) compatible energy-management module, the Model 100-EMM, is available from Fulcrum Computer Products Ltd. The module provides temperature-sensing facilities at four remote locations, relay or optoisolator on/off control for six external devices, and an eight-source fire or intruder alarm. Battery backup of the 100-EMM enables the alarm to operate independently of the host computer. The alarm has a 50-millisecond dwell period and three operating conditions. Temperature-sensing functions are provided by means of four pairs of contacts connected to thermistor-sensing transducers. Six relays, rated at 28 amperes, operate independently under software control and can handle air conditioners, water heaters, and so on.

The 100-EMM will verify the condition of up to eight sensors for fire alarm or intruder systems. Sensor inputs are equipped with protection circuits that will withstand transient switching voltages. It's suitable for use in industrial-control applications. RFI (radio frequency interference) suppression circuits are included to eliminate false triggering from nearby radio sources.

For further details on the 100-EMM module, contact Fulcrum Computer Products Ltd., Fulcrum (Europe), Valley House, Purleigh, Essex CM3 6QH, England; tel: (0621) 828763; Telex: 995411.■

Circle 643 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

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LNW 80 I	Z80A, 65K, 480 × 192	1,050

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CS1	5¼" floppy, Z80	3,196
CS1H	W/5 MB hard disk	5,596
CS1D2E	256K RAM, 68000 & Z80 two 5¼" floppy	4,396
CS1D2	no error correction	3,996
CS3D5E	512K RAM, 6800 & Z80 two 8" floppy	7,996
C10	64K, 12" monitor Z80A, keyboard	1,090

Professional/Word Process

ZENITH	Z90-80, 64K	2,050
NORTH STAR	HORIZON, 1 quad drive, HD5	3,999
	ADVANTAGE, 2 quad drives, 64K	2,999
CROMEMCO CIO Super pak	64K, 12" monitor, 390K floppy CP/M type O.S. + word processing + spreadsheet	1,650

Zenith 16-Bit

Z-110	dual drives, 128K RAM color board, 225 × 640 graphic, IBM PC compatible	3,099
ZVM-134	RGB 640 × 480	550

16-bit CPU

68000 EXPERT

WICAT	1 to 12 users, 256KB to 45MB, 10MB to 474MB hard disk, graphic option	9,000 up
DUAL	fast, durable, industrial grade system, 68000, 512K RAM, 20MB hard disk, IBM floppy, UNIX, S100	14,500

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dBASE II	Ashton-Tate database	499
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Micro Pro WORDSTAR		350
Digital Research CPM 2.2		139
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Many other software		CALL

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Intergral Data System		
MICROPRISM	75 cps excellent print/110 cps 84 × 84 graphic, RS232/parallel pin & friction feed	520
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	w/graphics 84 × 84	1,025
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	graphic, color, friction	1,590
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	92	560
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	7720 KSR	2,695
	3510	1,500
	3530	1,650
QUME	11 +	1,400
DIABLO	630	1,875

TERMINAL

ZENITH	Z29 smart terminal	670
	ZT-1 w/modem telecom	530
HAZELTINE	ESPRIT II	588
	III	760
BEEHIVE	DM5 A	995
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	300	948
	550 graphic	2,285
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ZENITH	12" green	114
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	COLOR II RGB 13"	699
	COLOR I 13"	340
	300 G 12" green	169
NEC	12" green	170
	1203 RGB	725
Electrohome	RGB 580 × 235	599

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	Concurrent CP/M 86	299
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What's the Creator of the Walkman® Doing Now?

Getting ready for another smash hit, of course.

Toshiaki Kamijo, creator of the Walkman®, has teamed up with the SORD Corporation, Japan's 2nd largest manufacturer of desktop computers, to develop an exciting new personal computer. So small it could rest on this magazine, light enough to tuck in your briefcase, and designed with an attention to quality that is unique, the M5 computer is a joy to own. Connect to a color TV or color monitor and enjoy instant BASIC, spreadsheet calculations (with optional FALC cartridge), or video games.

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☐ _____ M5 computer systems.

☐ _____ FALC cartridges.

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My check is enclosed.

☐ Please send more information.

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M5 Computer with BASIC-I Baseball and Zac Banic games, built-in RF modulator, all cables. 90 day warranty. Uses ordinary cassette recorder (not included). **$159 postpaid.**

FALC Cartridge. Electronic spreadsheet for the whole family. Do business calculations, count calories, keep a data base of sports statistics, all with no programming. **$40 postpaid.**

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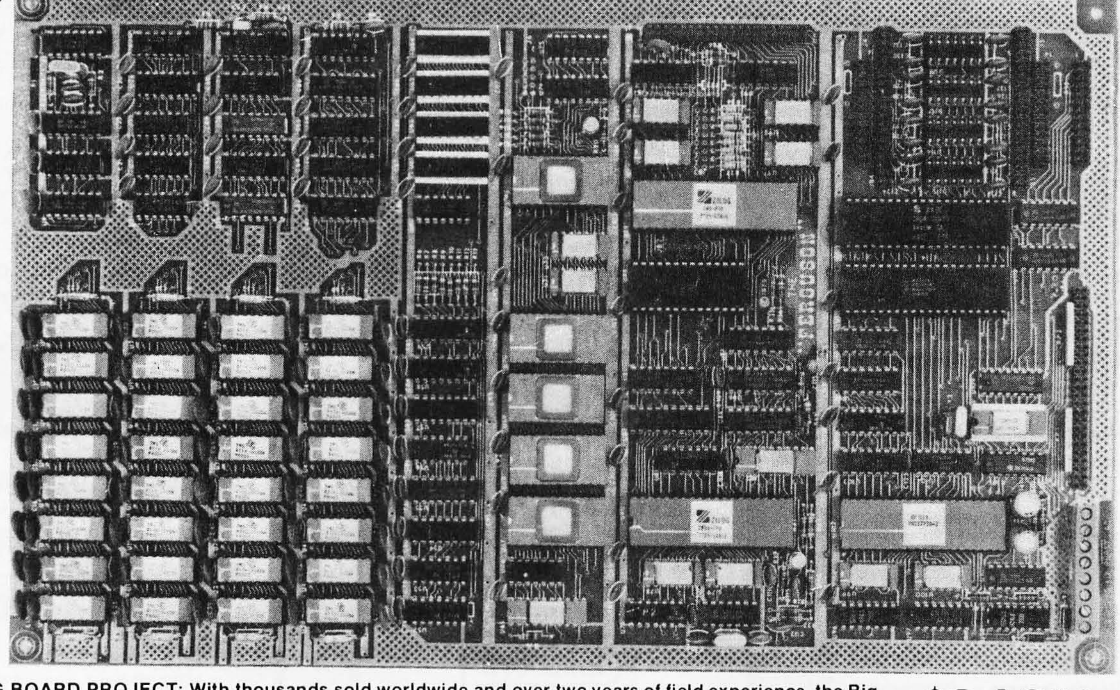
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Z-80 CPU! 64K RAM!

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The Big Board gives you the right mix of most needed computing features all on one board. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed.

$319.00 ** (64K KIT BASIC I/O)

SIZE: 8½ x 13¾ IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
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Uses Industry standard 4116 RAM's. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

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Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software.

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Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232! For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: $39.95

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Consists of separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

BLANK PC BOARD — $119

The blank Big Board PC Board comes complete with full documentation (including schematics), the character ROM, the PFM 3.3 MONITOR ROM, and a diskette with the source of our BIOS, BOOT, and PFM 3.3 MONITOR.

24 x 80 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true. 5 x 7 Matrix - Upper & Lower Case.

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Uses WD1771 controller chip with a TTL Data Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the SA800 or SA801. Drives can be configured for remote AC off-on. Runs CP/M* 2.2.

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Uses Z-80 PIO. Full 16 bits, fully buffered, bi-directional. Uses selectable hand shake polarity. Set of all parts and connectors for parallel I/O: $19.95

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Uses Z-80 CTC. Can be configured as a Counter on Real Time Clock. Set of all parts: $9.95

CP/M* 2.2 FOR BIG BOARD

The popular CP/M* D.O.S. to run on Big Board is available for $139.00.

BIG BOARD SOFTWARE SPECIAL — $149

Through special arrangement with CDL we offer a powerful package of TDL Z-80 software that has a suggested retail of almost $600. Includes: Extended Disk Business Basic, ZEDIT text editor, MACRO II Macro Assembler, LINKER, DEBUG I and DEBUG II. Supplied on 8 in. diskette with extensive manual.

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The real power of the Big Board lies in its PFM 3.3 on board monitor. PFM commands include: Dump Memory, Boot CP/M*, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search PFM occupies one of the four 2716 EPROM locations provided. Z-80 is a Trademark of Zilog.

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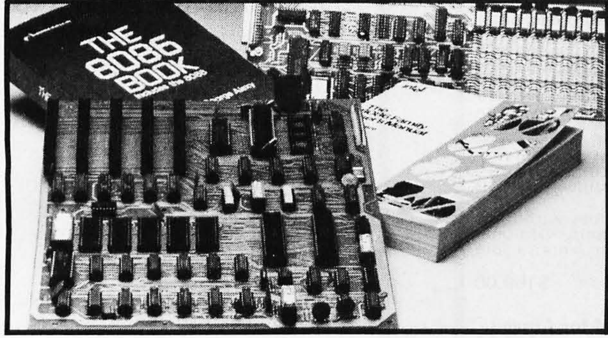
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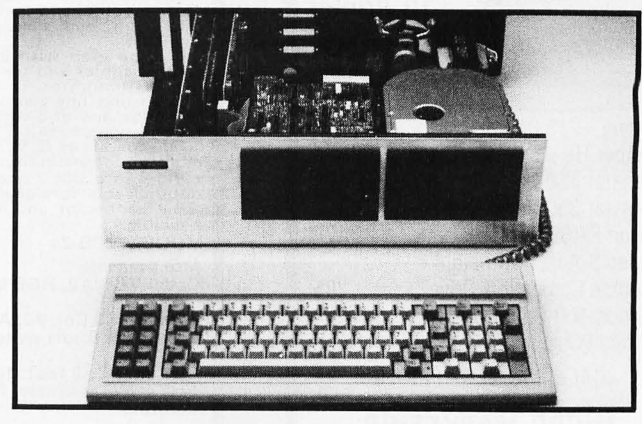
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IBM COMPATIBLE





LEARN 16 BIT TECHNOLOGY IN EASY LOW-COST STEPS. This 2-board system features (1) an 8088 mother board with a 5-slot expansion bus that will accept any hardware designed for the IBM personal computer and (2) a 64K (expandable to 256K) memory board that also features an IBM compatible RS 232 communications port. All circuits are functionally equivalent to the IBM except for the cassette ROMS. This means that all programs written in basic designed to run in an IBM can be compiled to run in this system and that any disk-operating system that will run on an IBM will work directly in the EXPLORER 88-PC. The system monitor ROM included in the Starter's system features a user-friendly operating system that allows easy program generation and debugging. The commands include display/modify memory...display/modify registers...input/output data to I/O ports...block moves...single-step trace mode...go/run with optional breakpoint and register reports...cassette load/save with file labels...plus a complete system test program that tests and reports condition of ROM, RAM, cassette interface, timer, DMA controller, interrupt controller, and the communications port. These test programs not only allow easy debugging of software but they serve as hardware and software learning tools.

The EXPLORER 88-PC STARTER'S KIT includes a mother board, memory/I/O board, all components needed, sockets for IC's used, one 62-pin bus connector and complete assembly/test instructions. All you need is a soldering iron, solder, a +5 volt @ 3 amps & -5 & +/- 12 volt @.5 amp power supply, and a standard RS 232 terminal (Netronics has 2 low-cost ones to choose from).

☐ Explorer 88-PC Starter's Kit ...$399.95 + 10.00 p&i (wired & tested, add 100.00).
☐ Extra 62-pin connectors @ 4.25 ea. + 1.00 p&i.

If you do not own a terminal you may want to consider using our IBM compatible keyboard (see photo) in conjunction with an IBM compatible color graphics board. This combination, although not necessary at the introductory level, may be desirable if you plan to expand the EXPLORER 88-PC to be fully IBM compatible. These items require additional power and are only available wired and tested as follows:

☐ IBM compatible keyboard...$299.95 + 10.00 p&i
☐ IBM compatible color board...$299.95 + 10.00 p&i
☐ Additional ROM required...$35.00

The EXPLORER 88-PC can be expanded at any pace you decide. Invest and learn at a pace that is comfortable for you. Netronics is dedicated to supplying the finest hardware and software to make this a meaningful learning experience. Hard disks, built-in modem board, eprom burner, print buffer system plus more will be available shortly. The following items are available now:

Deluxe heavy-duty steel cabinet that houses either two 5¼" floppies or a 5¼" hard disk with one floppy. This cabinet features a brush-finish front panel and a wood-grained sleeve that gives the unit a real professional look.

☐ EXPLORER 88-PC Cabinet...$199.95 + 18.00 p&i.

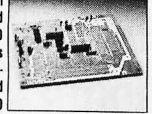
A heavy-duty open frame power supply with fan that can be used in your own cabinet or installed into the Netronic cabinet is available as follows:

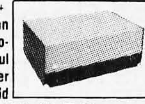
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☐ The monitors and BIOS source listings are available on either disk or hard copy at $35.00. Please specify format and system required.
☐ INTEL 8086/8088 user manual...$15.00 + 1.50 p&i.
☐ THE 8086 BOOK by RECTOR & ALEX...$16.00 + 1.50 p&i.
☐ Special IBM compatible system: with keyboard, color graphics board, floppy disk controller, 64K RAM, cabinet, standard power supply and a single 5¼" floppy drive...$1899.95 + 25.00 p & i.

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EXPLORER 85

Learn computing from the ground up. Start with the Explorer/85 Level 'A' kit which includes an expandable mother board. The Kit includes the 8085 CPU, 2K Monitor program used to enter, test, run and save programs plus the parts to allow you to start programming. Just add a power supply and terminal or hex keyboard. ☐ LEVEL A Terminal version or ☐ Hex Keypad version 129.95 + 3.00 p&i. Add ☐ Level 'B' 49.95 + 2.00 + two 100 pin connectors @4.85 ea. and have a powerful S-100 computer. Add ☐ Level 'C' 39.95 + 2.00 p&i + five 100 pin connectors to increase S-100 slots to 6. Add memory using the JAWS 16-64K S-100 board or add ☐ Level 'D' 4K to main board 49.95 + 2.00 p&i. ☐ Level 'E' 5.95 + 1.50 p&i adds decoding for 8K of 2716 eproms. Need a power supply? Use the ☐ 5 amp AP-1 at 39.95 + 2.00 p&i. Select one of our low-cost terminals or use the ☐ Hex keypad w/display at 69.95 + 2.00 p&i. ☐ Deluxe system cabinet 49.95 + 3.00 p&i. ☐ Optional fan 16.50. Now add ☐ Microsoft 8K basic & a powerful ☐ Text editor/assembler in ROMS, just 99.95 ea. Add ☐ 8" floppy 499.95 + 12.00 p&i. ☐ Floppy controller board 199.95 + 2.00 p&i. ☐ Floppy cabinets & power supply 69.95 + 3.00 p&i. ☐ Two drive cable 29.95 + 1.50 p&i. Hard disk also available (see insert.)





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☐ **Beginner Pak** (Save $26.00) - You get Level A (Terminal Version) with Monitor Source Listing ($25 value) AP-1 5-amp power supply. Intel 8085 Users Manual...(Reg. $199.95) SPECIAL $169.95 plus $4 p&i.

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☐ **Special Microsoft BASIC Pak** (Save $103.) - You get Levels A (Terminal Version). B.D. (4k RAM) E. 8k Microsoft in ROM. Intel 8085 User Manual. Level A Monitor Source Listing and AP-1 5-amp. power supply...(Reg. $439.70) SPECIAL $329.95 plus $7 p&i. ☐ Add a Rom-Version Text Editor/Assembler (Requires Levels B and D or S100 Memory).... $99..95 plus $2 p&i.

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JAWS MEMORY BOARD. Features the INTEL 8202 for invisible refresh. Designed to be used with 8080, 8085 and Z80 CPU's. Works in all well designed S-100 computers, 10 day refund (or exchange wired unit for a Kit) on wired units.

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☐ 48K Kit 249.95*	☐ 48K wired 299.95*
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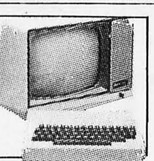
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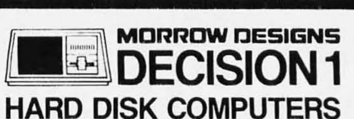
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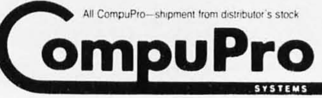
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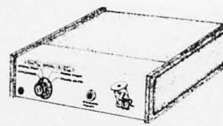
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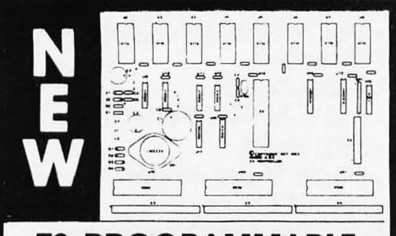
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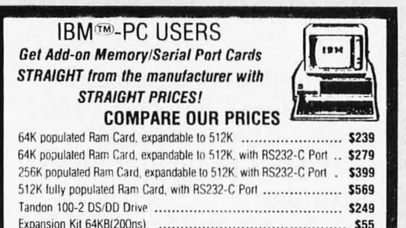
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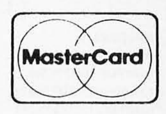
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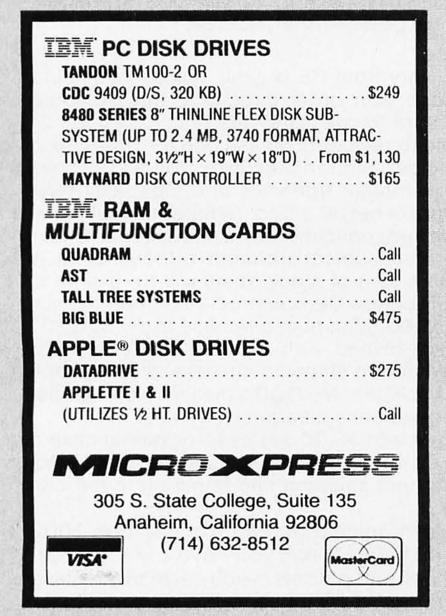
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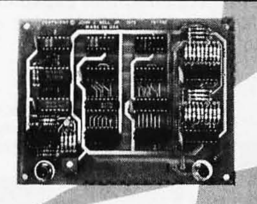
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JBEs Speech Synthesizers use the Votrax SC-01 Phoneme Synthesizer chip. The SC-01 phonetically synthesizes continuous speech of unlimited vocabulary. The SC-01 contains 64 different phonemes and 4 levels of inflection accessed by an 8 bit code. It requires 10 Bytes per second for continuous speech. Both boards have an audio amp for direct connection to an 8 ohm speaker.

Documentation includes basic user programs, a phoneme chart and listing of coded words to help you get started. Documentation for the Apple II® Speech Synthesizer includes a disk with text to speech program.

81-088 Apple II Speech Synthesizer	**$129.95**
81-120 Parallel Input Speech Synthesizer	**$149.95**
Prices include the SC-01 Chip	
SC-01 sold separately for	**$ 39.95**

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79-287	ASSM. **$79.95**
Bare Board	**$39.95**

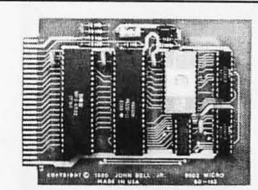
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6502 MICROCOMPUTER

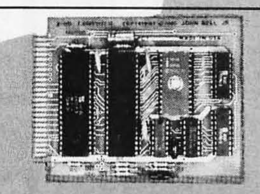


6502 MPU, 6522 VIA, 2716 EPROM, 2114 RAM single board computer. Single 5 volt power supply at 400 Ma. Two independent 8 bit I/O ports with handshake lines. RC controlled 1 MHz clock.

Complete documentation. I/O lines use 50 pin edge connector. Data and address lines are not accessible. Mod. for 2532 is included. EPROM is not included. 1K RAM, 2K EPROM, 2 I/O ports.

80-153	Assm. **$110.95**

Z-80 MICROCOMPUTER

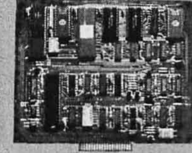


Z-80 MPU, Z-80 PIO, 2716 EPROM, 2114 RAM single board computer. Single 5 volt power supply at 300 Ma. Two independent 8 bit I/O ports with handshake lines. RC controlled 2MHz clock.

Complete documentation. I/O lines use 50 pin edge connector. Data and address lines are not accessible. Mod. for 2532 is included. EPROM is not included. 1K RAM, 2K EPROM, 2 I/O ports.

80-280	Assm. **$129.95**

VIDEO TERMINAL BOARD

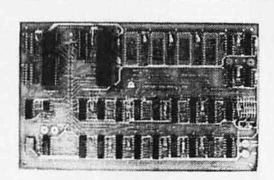


This is a complete stand alone Video Terminal board. All that is needed besides this board is a parallel ASCII keyboard, standard NTSC monitor, and a power supply.

- 6502 Microprocessor
- 6545-1 CRT controller
- 2716 EPROM char. gen.
- 2716 EPROM program
- 4K RAM (6116)
- RS232 I/O for direct connection to computer or modem
- 80 columns X 25 line display
- Size 6.2" X 7.2"
- Output for speaker (bell)
- Power +5 700 Ma.
  +12 50 Ma.
  −12 50 Ma.

This board is available assembled and tested. 82-018A **$199.95**
Bare board with EPROMS and crystal. 82-018B **$ 89.95**
Both versions come with complete documentation.

MINI VIDEO 40 X 24



This board can be used to add a video display to your AIM or other computer. It can also, with the addition of a parallel keyboard, 5V power supply and video monitor, be used as a home computer. It will run Tom Pittman's Tiny Basic. The 2716 character gen. will produce 256 8x8 characters, ASCII upper and lower case and graphic characters. The 44 pin expansion connector can be used to add up to 6K of memory or extra I/O ports. Power requirements: 5 volts 600 MA 3 watts.

Documentation includes schematic, parts list, connector pin outs, and source listing for video display and Monitor. Control character response:

- H back space
- I up one line
- J line feed
- L clear screen and home
- M carriage return
- U forward space non destructive

The curser is flashing underline type.

82-140A assm. W/O EPROMS	**$149.95**
Character Gen. A7	**$ 19.95**
Tiny Basic + Monitor	**$39.95**
GPIO Parallel Input	**$ 19.95**
Bare Board with doc.	**$ 79.95**

JBE I MICROCOMPUTER

JBE's 7.75 x 11.75 6502 base Microcomputer has the capacity for 16K of EPROM, 4K of RAM, 8 Parallel Ports and 1 Serial Port. Monitor and Tiny Basic are also available.

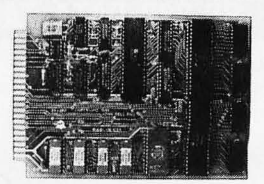
Both versions include sockets for 2716s or 2532s, 8 16 pin sockets for I/O interfacing and a DB25 connector for RS232.

All address and data lines are brought off the board to the 50 pin edge connector. (Similar to the Apple II bus.)

This board also features power on reset and cassette interface.

81-030C Fully Populated	**$399.95**
81-030M Partially Populated	**$299.95**
2716 EPROM (with Tiny Basic)	**$ 19.95**

81-260 "SLIM"



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- 6502 MPU
- Two 6522 VIA's
- Four 2114 RAM's (2K bytes)
- One EPROM 2516 or 2532
- Crystal clock 1 MHz
- Requires 5V 1AMP power
- 4.5 x 6.5 card
- Power on reset
- Fully buffered-expandable
- Solder mask-both sides

Use your Apple II Computer, JBE 6522 Parallel Interface card and EPROM Programmer as a development system for SLIM.

81-260A	Assm. **$199.95**

PHERIPHERALS FOR SLIM

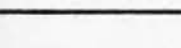
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81-350A Assembled	**$149.95**
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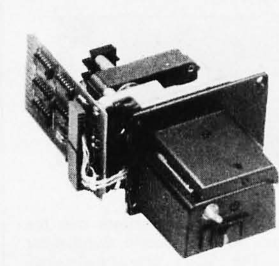
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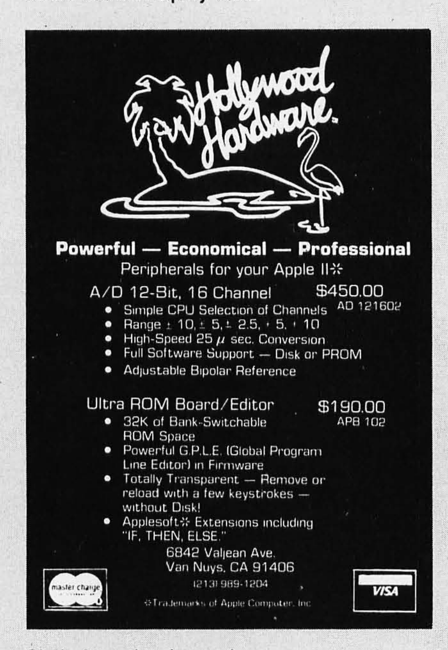


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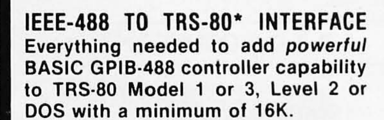
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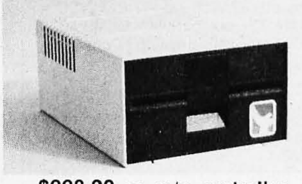


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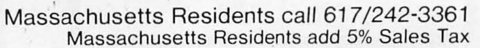
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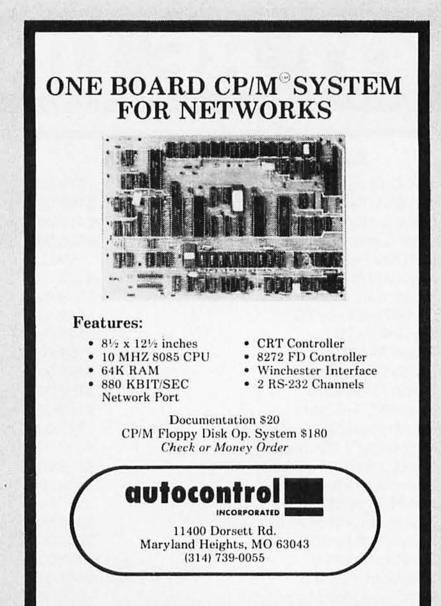
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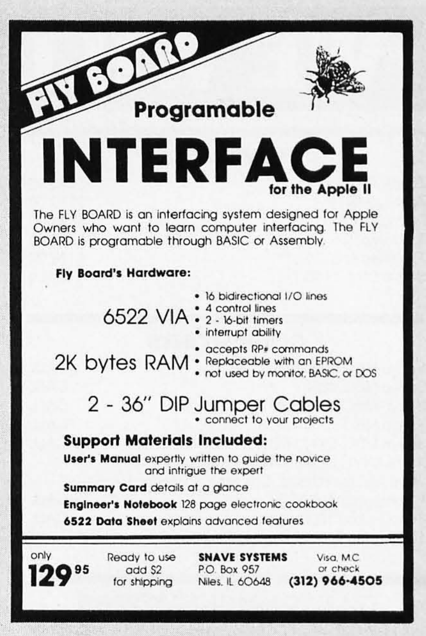
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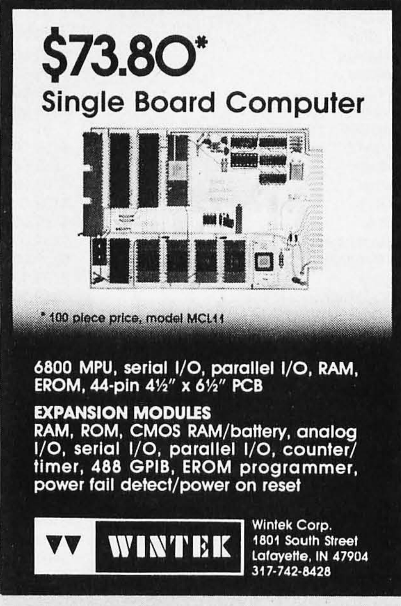
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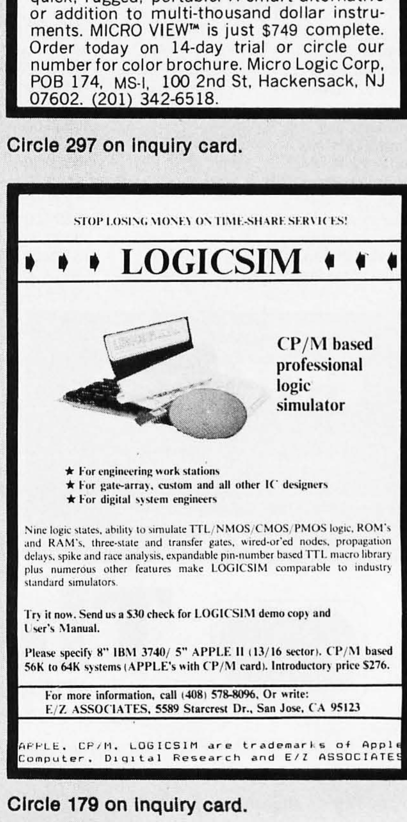
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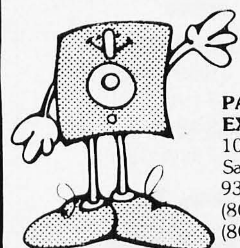
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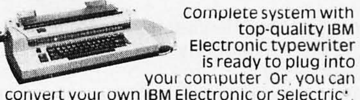
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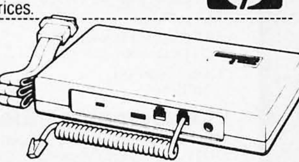
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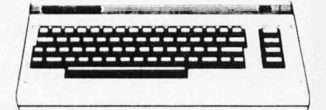




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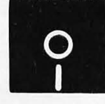
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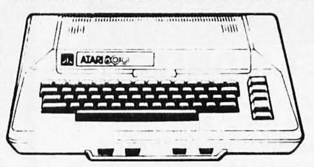
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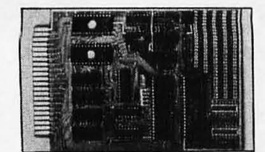
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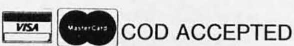
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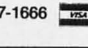


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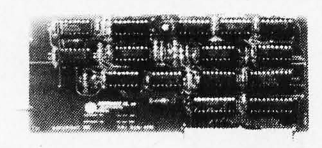
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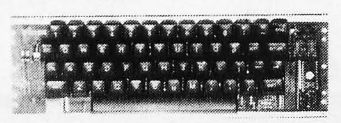
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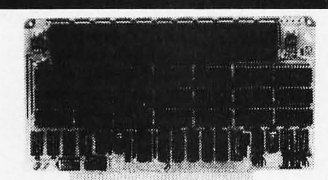
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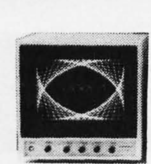
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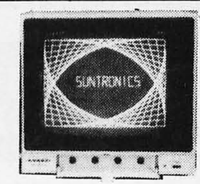
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ADDS VIEWPOINT 3A/PLUS........... **$545.00**

S-100 Products

SBC-880 Z80A CPU, A&T **$195.00**
SBC-880 Z80A CPU, Kit **$175.00**
4MHz Z80A CPU Board with Serial/Parallel Ports
UFDC-1 Floppy Controller, A&T **$245.00**
UFDC-1 Floppy Controller, Kit........... **$225.00**
The UFDC-1 Floppy Controller uses the WD1795 chip which runs either and/or 8"/5¼" Disk Drives.
CLOCK CALENDAR A&T................ **$115.00**
CLOCK CALENDAR Kit.................. **$95.00**
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SUN-721 S-100 Prototype Board **$17.85**
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S-100 Mainframes 6 -12 Slots

DMF8800T 6 Slot, Dual Thin 8" Drives... **$699.00**
DMF8800 6 Slot, Dual Std. 8" Drives ... **$699.00**
DMF5550 6 Slot, Up to 3-5¼" Drives ... **$679.00**
DMF2200 6, 8, 12, 18, 22 Slot MB .... **Call**
All Mainframe Power Supplies rated at 8V @ 18A, ±16V @ 23A, 24V @ 5A, 12V @ 5A & 5V @ 5A.
All cabinets made of strong steel with aluminum covers & incl EMI A/C power filter w/detachable power cord, quiet fan for pos. air pressure (blows dust out, not in), back panel has individual covers with (12) DB25 cutouts, (2) Centronics 36 pin cutouts, (1) 34 pin & (1) 50 pin flat ribbon cutout, (2) A/C convenience outlets (1 switched & 1 unswitched), keyed power, lighted reset switches, & tan cover with black face match most decours.

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SLOTS	Bare Bd	KIT	A & T	w/CAGE
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8	16.00	45.00	70.00	105.00
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10MHz, No termination Required!

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NEC Spinwriters 3500, 5500, 7700.......... **Call**

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P/N	1-7	8 up	P/N	1-7	8 up
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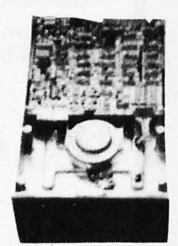
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*Orders accepted by Visa/MasterCharge (add 3%) Money Order or certified check. Price does not include shipping charges. Specify method of shipment desired and include approximate shipping charge. N.J. residents add 6% sales tax.

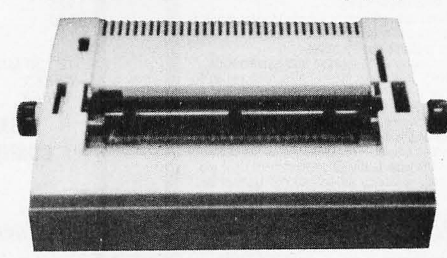
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These Qume Printers were used by a major typesetting company under maintenance until replaced by laser printers on an exchange basis. We had their technicians refurbish and completely exercise them to give you many years of reliable service at a price you can live with.

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Input — 115V 60 Hz **2.0 Amps — 11.5 VDC**
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WIZARD BPO 16K	149.00
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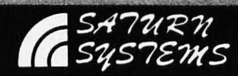
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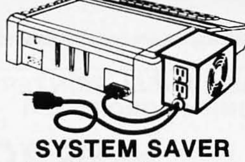
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S-100 MEMORY BOARDS

64K STATIC RAM - Jade

Uses new 2K x 8 static RAMs, fully supports IEEE 696 24 bit extended addressing, 200ns RAMs, lower 32K or entire board phantomable, 2716 EPROMs may be subbed for RAMs, any 2K segment of upper 8K may be disabled, low power typically less than 500ma.

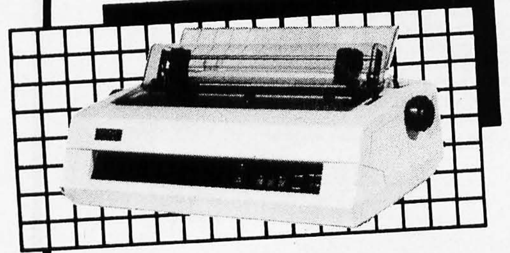
MEM-99152B	*Bare board*	**$49.95**
MEM-99152K	*Kit less RAM*	**$99.95**
MEM-32152K	*32 kit*	**$199.95**
MEM-56152K	*56K kit*	**$289.95**
MEM-64152K	*64K kit*	**$299.95**
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LETTER QUALITY PRINTERS

Letter Quality Printer - COMREX

Uses standard daisy wheels and ribbon cortridges, 16 CPS bi-directional printing, semi-automatic paper loader (single sheet or fan fold), 10/12/15 pitch, up to 16" paper, built-in noise suppression cover.

PRD-11001	*Centronics parallel*	**$899.95**
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PRA-11000	*Tractor Option*	**$119.95**



380Z by D.T.C.

Based on the same quality mechanism as the Comrex printer, the 380Z contains electronic enhancements that allow it to print at speeds up to 32 CPS. Other features include a 48K buffer, proportional spacing, and Diablo 1640/1650/630 compatible protocol. Comes with printwheel, ribbon and users manual. Serial, parallel, and IEEE 488 interfaces standard.

PRD-11300	*380Z printer*	**$1295.00**
PRA-11000	*Tractor option*	**$169.95**
PRA-1200	*Cut sheet feeder*	**$699.95**
Cable	*Please specify*	**$49.95**

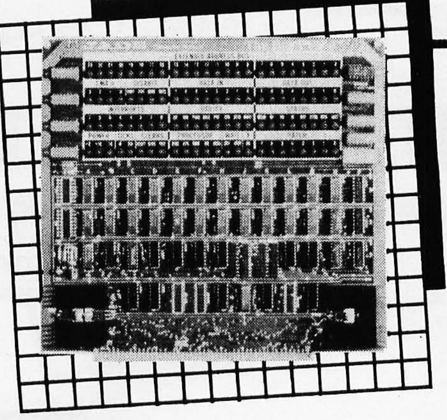
Printers From Jade

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OKIDATA 83	*15" 120 CPS with Tractor*	**CALL**
OKIDATA 84	*15" 200 CPS with Graphics*	**CALL**
OKIDATA 2350	*15" 350 CPS*	**CALL**
OKIDATA 2410	*15" 350 CPS, Two color*	**CALL**
DAISYWRITER 2000	*48K Daisywheel*	**$1395.00**
GEMINI 10	*100 CPS 10" with Graphics*	**$349.95**
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Desk top printer stand and paper rack. Fits all printers.

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S-100 I/O BOARDS

The BUS PROBE — Jade

Inexpensive S-100 Diagnostic Analyzer

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TSX-200A	*A & T*	**$159.95**

I/O-4 — SSM Microcomputer

2 serial I/O ports plus 2 parallel I/O ports

IOI-1010B	*Bare board w/manual*	**$35.95**
IOI-1010K	*Kit with Manual*	**$179.95**
IOI-1010A	*A & T*	**$249.95**

I/O-5 — SSM Microcomputer

Two serial & 3 parallel ports, 110-19.2K Baud

IOI-1015A	*A & T*	**$289.95**

INTERFACER 4 — CompuPro

3 serial, 1 parallel, 1 Centronics parallel

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IOI-1830C	*CSC*	**$414.95**

S-100 EPROM BOARDS

PB-1 — SSM Microcomputer

2708, 2716 EPROM board with on-board programmer

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MEM-99510A	*A & T with manual*	**$219.95**

PROM-100 — SD Systems

2708,2716, 2732 EPROM programmer with software

MEM-99520K	*Kit with software*	**$189.95**
MEM-99520A	*A & T with software*	**$249.95**

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VIDEO MONITOR — Jade

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12" GREEN SCREEN — Zenith

15MHz, 40 or 80 column

VDM-201201	*12" Green*	**$114.95**

DUAL DISK SUB-SYSTEMS

DISK Sub-Systems — Jade

Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power supply power cable kit, power switch, line cord, fuse holder, cooling fan, nevermar rubber feet, all necessary hardware to mount 2-8" disk drives, power supply, and fan, does not include signal cable.

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END-000436	*Kit w/2 Shugart SA-851Rs*	**$1274.95**
END-000434	*A & T w/2 Shugart SA-801Rs*	**$1195.00**

S-100 MOTHERBOARDS

ISO-BUS - Jade

Silent, simple and on sale — a better motherboard

6 Slot (5¼" x 8⅝")

MBS-061B	*Bare board*	**$22.95**
MBS-061K	*Kit*	**$39.95**
MBS-061A	*A & T*	**$69.95**

12 Slot (9¾" x 8⅝")

MBS-121B	*Bare board*	**$34.95**
MBS-121K	*Kit*	**$69.95**
MBS-121A	*A & T*	**$109.95**

18 Slot (14½" x 8⅝")

MBS-181B	*Bare board*	**$54.95**
MBS-181K	*Kit*	**$99.95**
MBS-181A	*A & T*	**$149.95**

S-100 CPU BOARDS

The BIG Z — Jade

2 or 4 MHz switachable Z-80 CPU board with serial I/O accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600.

CPU-30201B	*Bare board w/manual*	**$35.00**
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CPU-30201A	*A & T with Manual*	**$199.95**

2810 Z-80 CPU — C.C.S.

2 or 4 MHz Z-80 CPU with serial I/O port & on board monitor PROM, front panel compatible

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CPU-Z CompuPro

2 or 4 MHz Z80A CPU, 24 bit addressing

CPU-30500A	*2/4 MHz A & T*	**$279.95**
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Both 8 & 16 bit CPUs, standard 8 bit S-100 bus, up to 8 MHz, accesses 16 Megabytes of memory

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Your Choice
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Single Side Double Density

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VERBATIM	525-01	525-10	NA	26.50
MAXELL	MD1	MH1-10	MH1-16	29.85
DYSAN	104/1D	107/1D	NA	45.00

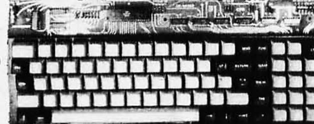
Double Side Double Density

SCOTCH	745-0	745-10	745-16	42.50
VERBATIM	550-01	550-10	NA	42.50
MAXELL	MD2-D	MH2-10D	MH2-16D	45.00
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

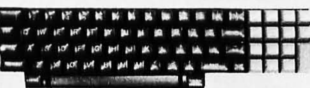
EIGHT INCH DISKETTES

Single Side Single Density			Single Side Double Density		
SCOTCH	740-0	29.50	SCOTCH	741-0	39.00
MEMOREX	3060	29.50	MEMOREX	3090	35.00
DYSAN	3740/1	39.50	DYSAN	3740/D	57.50
Thirty Two Sector			**Double side Double Density**		
SCOTCH	740-32	29.50	SCOTCH	743-0	47.50
Scotch Head Cleaning Kits 5¼ & 8"		$24.95	MEMOREX	3114	39.50
Plastic Library Cases 5¼ & 8"		2.95	DYSAN	3740/2D	65.00
Diskette Flip Tubs fifty diskettes 5¼"					
Diskette Flip Tubs fifty diskettes 8"					

Microswitch ASCII KEYBOARD $79



Each keyboard contains 81 high reliability Hall Effect keys. Outputs seven bit parallel ASCII MIC-81SD5 3 Lbs.



HITEK KEYBOARD $24.95

This Hitek keyboard is the same unit used by Lear Siegler in their middle line CRT terminals. The keyboard features 58 unencoded metal on metal contacts (HIK-58). Matching numeric cluster with 15 keys is available for $9.95 (HIK-15). Buy both of these units for only $29.90 and save $5.00 (HIK-5815)

MEMORY

16K DYNAMIC	2732 EPROM
1.95	**4.95**
4116 150ns.	450ns.
64K DYNAMIC	**16K STATIC**
6.95	**4.95**
4164 150ns.	6116 200ns.



2764 EPROM SALE $9.95

DYNAMIC MEMORY

		1-31	32+	100+
4027 4K dynamic 250ns.	ICM-4027250	1.99	1.85	1.75
4116 150ns. 16K	ICM-4116150	1.95	1.85	1.75
4116 200ns. 16K	ICM-4116200	1.75	1.65	1.50
4164 150ns. 64K 128 refresh	ICM-4164150	6.95	6.50	5.90
41256 150ns. 256K	ICM-41256150	Available March 83		

STATIC MEMORY

21L02 200ns. 1K static	ICM-21L02200	1.49	1.29	1.15
21L02 450ns. 1K static	ICM-21L02450	1.29	1.15	.99
2112 450ns. 2K static	ICM-2112450	2.99	2.85	2.75
2114 300ns. 1K x 4	ICM-2114300	1.95	1.85	1.75
4044TMS 450ns. 4K x 1	ICM-4044450	3.49	3.25	2.99
5257 300ns. 4K x 1	ICM-5257300	2.50	2.25	1.99
6116 P4 200ns. 2K x 8	ICM-6116200	4.95	4.80	4.65
6116 P3 150ns. 2K x 8	ICM-6116150	5.95	5.75	5.60
6167/2167 100ns. 16K x 1 (20 pin)	ICM-6167100	8.95	8.50	7.90

EPROMS

2708 450ns. 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns. 2K x 8	ICE-2716	4.95	4.75	4.55
2716TMS 450ns. Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns. 4K x 8	ICE-2732	4.95	4.75	4.55
2732 350ns. 4K x 8	ICE-2732350	8.50	8.00	7.60
2532 450ns. 4K x 8	ICE-2532	10.50	9.90	9.50
2764 350ns. 8K x 8	ICE-2764	10.95	10.50	9.95
27128 350ns. 16K x 8	ICE-27128	Available March 83		

CONNECTORS



S-100 Gold $2.95

DB25P $2.50

GOLD EDGE CONNECTORS

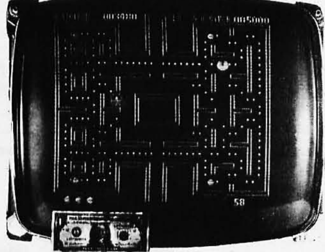
S-100 .125" centers	each	10+
Imsai solder .250" row	$2.95	$2.50
Imsai wire wrap (TI)	3.95	3.50
Sullins Hi-Rel. .250"	4.50	4.00
Sullins Hi-Rel. W/W	5.35	4.90
Sullins / Altair .140"	4.95	4.50
.156" Centers (standard)		
22/44 Kim Eyelet	2.50	2.15
36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

INTEGRATED CIRCUIT SOCKETS

	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
DC37P male	4.20	4.00	3.70
DC37S female	6.00	5.75	5.50
DC hood 2/P	2.25	2.00	1.75
DD50P male	5.50	5.10	4.75
DD50S female	9.40	8.60	8.00
DD50 hood 2/P	2.60	2.40	2.10
CENTRONICS			
57-30360	7.95	6.75	5.75
RIBBON CABLE CONNECTORS			
17/34 5" disk	4.85	4.15	3.95
20/40 TRS-80	5.65	5.05	4.70
25/50 8" disk	5.90	5.15	4.90

23" COMPOSITE MONITOR $159



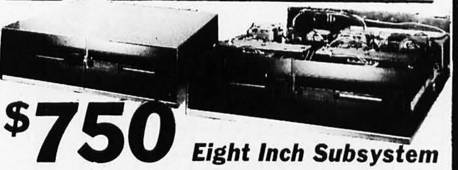
Ideal monitor for classroom demonstrations.

Ever try gathering a classroom of students around a 12" monitor? Here is your opportunity to purchase a 23" high resolution monitor at a reasonable price.
These units accept standard composit video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in second you are shooting down Klingons in wide screen video.
MOT-BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional CAL-ENC23 15 Lbs.



Eight Inch Single Sided	One	Two	Ten
SHUGART SA801R	$395	385	375
SIEMENS FDD100-8	259	259	225
TANDON 848-1 SLIMLINE	379	369	359
Eight Inch Double Sided			
SHUGART SA851R	525	495	475
QUME DATA TRACK 8	525	495	475
MITSUBISHI M2894-63	485	475	469
OLIVETTI 802/851	369	359	349
TANDON 848-2 SLIMLINE	495	485	475
SHUGART 860 THINLINE	569	549	539
Five Inch Single Sided			
SHUGART SA400	215	209	199
TANDON TM 100-1	209	199	195
Five Inch Double Sided			
SHUGART SA450	349	329	315
TANDON TM 100-2	295	269	259
TANDON 96TPI TM100-4	369	355	350
OLIVETTI 502 ⅔ height	239	225	215
Three Inch Rigid Floppy			
HITACHI-AMDEK	call for pricing		
Five Inch Winchesters			
SEAGATE 506 6 Megabyte	759	725	695
SEAGATE 512 12 Megabyte	995	960	960
TANDON 603SE 14 Megabyte	995	960	895
WESTERN DYNAX removable	995	960	950

Upon request, all drives are supplied with power connectors and manual



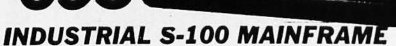
$750 Eight Inch Subsystem

Two Siemens FDD100-8 disk drives with power supply, 4" exhaust fan complete with all necessary power cables.

Same as above but with:

Shugart 801R	MSD2801	$1195	Olivetti 802	CAL2802	$1250
Shugart 851R	MSD2851	1450	Qume DT8	MSD8DT	1450

ECLIPSE 100 $695



INDUSTRIAL S-100 MAINFRAME

Suitable for hospital and industrial applications. Constructed from 304 brushed stainless steel. Modualar 500 watt toroid power supply provides +8 volts at 30 Amps and ±16 volts at 4 Amps. Supplied with standard 18 slot Faraday mother board. Auxilary switched AC receptacles. The Eclipse 100 can be either table or rack mounted. Provisions for internally mounting a ten megabyte Winchester disk drive.
The Eclipse 100 is the perfect mainframe to fill the void left by the now defunct TEI Corporation. EPS-100 50 lbs.



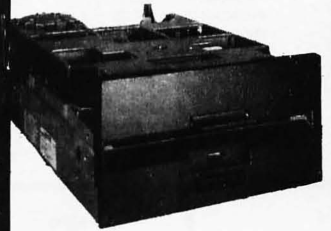
Shipping: First five pounds $3.00. Each additional $.50.
Foreign orders: 10% shipping. Excess will be refunded.
California residents add 6½% sales tax. COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a "strong" Dun & Bradstreet.
Warehouse: 15608 Inglewood Blvd. Visitors by appointment.

TOLL FREE ORDER LINE
(800) 421-5041
TECHNICAL & CALIFORNIA
(213) 679-9001

California Digital

Post Office Box 3097 B • Torrance, California 90503

Super Buy $219



SIEMENS FDD 100-8 8'' DISK DRIVE

10 Drives $209 • 100 Drives $175

California Digital has recently participated in the purchase of several thousand Siemens FDD 100-8 floppy disk drives. These units are electronically and physically similar to that of the Shugart 801R. Any application that will accept the Shugart will work with the Siemens FDD 100-8.
All units are new and shipped in factory sealed boxes. Because of the extremely low price we expect a quick sell out. SEA-F1008 17 lbs. Manual and power connectors supplied free upon request. Also available: Two drive subsystem supplied in metal enclosure with power supply and exhaust fan. $750.00 CAL-2F1008.

FREEDOM 50 SPECIAL SALE $475

California Digital gives you a great price on the Freedom 50 terminal. Includes detachable keyboard with 93 keys including 10 function keys, 15 graphic symbols, and DIP-switch selectable character set for 7 foreign languages. The 12 inch etched non-glare green phosphor screen displays 24 rows by 80 characters in 7x9 matrix with true descenders. Self test and 25th data display row also included. Switch-selectable baud rates from 110-19.200 baud. Bi-directional auxillary serial port with baud rates from 110-19.200 baud. Other standard features include both block and conversion modes. Screen attributes do not use display memory, allowing operator to display a full 1920 characters. Emulates 5 popular CRT terminals for easy software configuration. Switch selectable between 115 and 230 volt. We have never seen a terminal with all these features for the incredibly low price of $475.

PRINTERS

ECLIPSE 80FT



$297

MATRIX PRINTERS

Star Gemini-10 friction & tractor 100 char/sec. parallel	STR-G10	359.00
Star Eclipse 80FT friction & tractor	STR-E80FT	297.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	459.00
Okidata 83A serial & parallel 15" paper	OKI-83A	695.00
Okidata 84A serial & parallel 15" paper	OKI-84A	1079.00
Okidata 2350 (new) 350 char/sec	OKI-2350	1995.00
EpsonMX80FT with graphtrax, friction & tractor feed.	EPS-MX80FT	519.00
EpsonMX100 with graphtrax, 15" paper	EPS-MX100	695.00
NEC8023A parallel 9½" paper, graphics	NEC-8023A	485.00
Anadex 9500A high speed 15" paper	ADX-9500A	1279.00
Anadex 9501A high speed with graphics	ADX-9501A	1279.00
Datasouth 180 high speed 180 cps 15"	DSI-180	1295.00
Quantex 7030 corespondence quality 180 char/sec	QTX-7030	1535.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	495.00
Prowriter 8510 serial 9½ paper	PRO-8510S	639.00
Prowriter II 15" paper	PRO-2P	750.00
Printronix P300 high speed printer 300 lines per minute.	PTX-P300	4500.00
Printronix P600 ultra high speed 600 lines per minute.	PTX-P600	6150.00
Mannesmann Tally 1805 200 char/sec serial.	MAN-1805	1650.00

WORD PROCESSING PRINTERS

NEC7710 55char/second, serial interface	NEC-7710	2379.00
NEC7730 same as above only parellel interface	NEC-7730	2379.00
NEC3510 15" serial	NEC-3510	1775.00
Diablo 630 40 char/sec. serial	DBL-630	2250.00
Brother HR11 daisey wheel	BTH-HR1S	855.00
Brother HR11 serial interface	BTH-HR1S	895.00
Smith Corona TP-1 daisy wheel printer, serial	SCM-TP1S	659.00
Starwriter F10 serial	PRO-F10S	1475.00
Starwriter F10 parallel	PRO-F10P	1475.00

EPSON MX80 RIBBONS $6.95

MONITORS

Zenith Z121 green phosphor 12" 40/80 column switch ZTH-Z121	115.00
BMC 12A green phosphor 15 Mhz. composit video BMC-12A	88.00
BMC 12EN green phosphor 20 Mhz. high resolution BMC-12EN	139.00
NEC JB1201 green phosphor 18 Mhz composit video NEC-JB1201	169.00
NEC JB1260 green phosphor commercial grade composit NEC-1260	129.00
Motorola 23" open frame blk/white composit video MOT-BW23	159.00
Motorola 12" open frame blk/white reqires horz sync. & pow MOT-BW12	69.00
Conrac 9" open frame requires horz. sync & power supply CON-BW9	59.00
(COLOR)	
NEC JC1201 composit color NEC-JC1201	325.00
NEC RGB monitor NEC-1202DM	875.00
BMC 13" Composit video BMC-1400CL	273.00
BMC 13" RGB color monitor BMC-1401RGB	329.00
BMC interface card for Apple II for above RGB BMC-81RGB	149.00
Comrex/Hitachi 13" RGB high res. monitor COM-6600	539.00
Comrex/Hitachi 13" Composit color monitor COM-6500	395.00
Amdek color #1 composit video AMD-100	349.00
Amdek color #2 high res. RGB color monitor AMD-200	739.00
Amdek color #3 commercial grade color RGB AMD 300	475.00

DIRECT CONNECT MODEMS

Universal Data 103LP, line power, answer & originate	UDS-103LP	169.00
Universal Data 103LPJ, auto answer	UDS-103LPJ	209.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	209.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	450.00
Universal Data 212A, 300/1200 baud, auto answer	UDS-212A	595.00
Hayes Smart Modem 1200, auto answer, auto dial	HYS-212AD	575.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Micromodem 100, S-100, auto answer, auto dial.	HYS-100	319.00
Hayes Chronograph, time& date	HYS-CHR232	199.00
Novation "J" Cat, direct connect, auto answer	NOV-JCAT	119.00
Novation Cat, acoustic connect	NOV-CAT	159.00
Novation "D" Cat, direct connect via handset not phone line.	NOV-DCAT	169.00
Novation SmartCat 103, auto answer, auto dial.	NOV-SC103	219.00
Novation SmartCat 103/212, 1200 baud auto dial	NOV-SC212	529.00
Penrel 300/1200 baud, auto log-on, auto dial	PEN-212A	$795.00
Signalman Mark I, direct connect with terminal cable.	SGL-MK1	88.00
U.S. Robotics 212A, 300/1200 baud	USR-212A	485.00

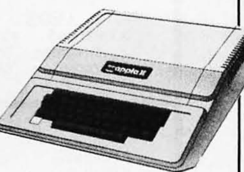
TERMINALS



Freedom 50, split screen, detatchable keyboard	LIB-F50	475.00
Visual 50, detatchable, keyboard selectable settings.	VSL-50	635.00
Visual 50 Green screen	VSL-50G	650.00
Visual 330, emulates DEC, DG, LSI, green	VSL-330G	995.00
Ampex Dialogue 80 green screen, two page, func. keys	APX-D80G	685.00
Ampex Dialouge 80 amber screen, two page, func. keys	APX-D80A	685.00
Wyse 100, horz & vert. split screen, metal enclosure	WYS-100	825.00
Televideo 910 Plus, block mode	TVI-910P	595.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	795.00
Televideo 950, graphic char., split screen, 22 func	TVI-950	985.00
Televideo 970, 14 green screen, 132 column, European	TVI-970	March
Zenith 19 terminal, VT52 compatible.	ZTH-Z19	765.00
ADDS Viewpoint A1 detatchable keyboard	ADD-VP1	585.00
ADDS Viewpoint A2, xy cursor	ADD-VP2	585.00

APPLE 48K Plus $1089





APPLE BRAND PRODUCTS

APL-48P	Apple Plus 48K RAM	
APL-DSK1	Apple disk with controller card	560.00
APL-DSK2	Apple disk without controller card	495.00

XITEN

XTN-G10	Xiten 10 Megabyte Gallium hard disk	1.995.00
XTN-16K	16K RAM card for Apple II	69.00

RANA SYSTEMS

RAN-APL1	Apple add on disk drive with controller	525.00
RAN-APL2	Apple add on drive without controller	395.00

CALIFORNIA COMPUTER SYSTEMS

CCS-7710	Asynchronous Serial Interface	125.00
CCS-7728	Centronics Parallel Interface	95.00
CCS-7720	Apple Parallel Interface	95.00
CCS-7114	12K Rom/Prom Module	115.00
CCS-7424	Calendar/Clock Module	95.00
CCS-7440	Programmable Timer	95.00
CCS-7811B	Arithmetic Processor for Apple II plus	319.00

MOUNTAIN COMPUTERS, INC.

MTN-CPS	CPS Multifunction Card	169.00
MTN-TCLK	Clock/Calendar	
MTN-STLK	Supertalker SD200	149.00
MTN-ROMF	Rom Plus with Keyboard filter	169.00
MTN-ROMRTR	Rom Writer with Eprom socket	145.00
MTN-ADDA	A•D/D•A Converter	269.00
MTN-BSR	X-10 Control Card for BSR system	149.00

MICRO SOFT

MSF-SFTCRD	Microsoft Z-80 CPU card	249.00
MSF-16KRAM	Microsoft 16K RAM card	125.00

VISTA

VSA-A800	Vista 8" controller card	489.00
VSA-VIS80	Vista Vision 80	289.00
MCI-CNTRL	Micro Sci disk drive controller	89.00

FOURTH DIMENSION

FDN-SPRDRV	Super Drive-35 track Apple add on	329.00

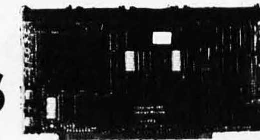
SORRENTO VALLEY ASSOC

SVA-221	Single sided, single density controller	360.00
SVA-222	Double sided, single density controller	360.00
SVA-223	Single or double sided, double density	475.00

ADVANCED BUSINESS TECH

ABT-13KEYN	13-Key pad for new Apple	95.00

S-100 BOARDS



16 BIT MICROPROCESSORS

GBT-8687	Godbout 8086/8087 Microprocessor board	495.00
GBT-8687	Godbout 8088/8085 dual 8 bit microprocessor	359.00
SEA-8086	Seattle Computer 16 bit micro two board set	669.00
TEC-8086	Tecmar Computer 16 bit microprocessor	595.00
LOM-8086	Lomas Data Systems Lighting One	call

SINGLE BOARD COMPUTERS

WAV-BLT1	Wavemate Bullet 1 with floppy 256K (not S-100)	795.00
AMD-Z80	Advanced Micro Digital, floppy & 64K	750.00
TEL-FDC1	Teletek FDC1 Single board NEC765 controller	675.00

8 BIT MICROPROCESSORS

GBT-Z80	Godbout Z80 8 bit CPU 24 bit extended address	250.00
CCS-2810	California Computer Z-80 microprocessor	275.00
SDS-SBC200	SD Systems SBC-200 Z-80 microprocessor	275.00
MSM-Z80	Measurement System Z-80 2810 microprocessor	425.00
TAR-Z80	Tarbell Electronics Z-80 with two RS232 ports	395.00

FLOPPY DISK CONTROLLERS

GBT-DSK1	Godbout Disk One double density NEC-765	395.00
MDS-DJ2	Morrow Designs Disk Jockey II with CPM	350.00
MDS-DJ1	Morrow Designs Disk Jockey I single density	225.00
CCS-2422	California Computer 2422 with CPM	339.00
TAR-DDC	Tarbell Electronics double density controller	419.00
TAR-SDC	Tarbell Electronics single density controller	279.00

CPM OPERATING SYSTEM

GBT-CPM22	Godbout CPM 2.2 for Disk One 8 bit operation	160.00
GBT-CPM86D	Godbout CPM 86 for Disk One for use with 8088	265.00
GBT-CPM86	Godbout CPM 86 for operation with 8086 board	265.00

HARD DISK CONTROLLER

GBT-DSK2	Godbout Disk II hard disk controller	695.00
GBT-DSK3	Godbout Disk III hard disk controller	
MDS-W506	Morrow Designs Winchester for Seagate 506	495.00
WDI-1000	Western Digital WD-1000 (not S-100)	495.00

EPROM BOARDS

ADS-PB100	Ackerman Digital Prom Blaster 100	275.00
SDS-P100	SD Systems Prom-100 programmer	260.00
SSM-PB1	SSM Prom prgrammer up to 2716	195.00
DGR-P32	Digital Research 32K Eprom read only board	105.00

STATIC MEMORY BOARDS

CAL-S64	California Digital Static 64 8/16 bit (6167)	595.00
GBT-R16	Godbout Ram 16 64K memory 8/16 bit	760.00
GBT-R17	Godbout Ram 17 64K memory 8 bit 24 bit add	395.00
GBT-R20	Godbout Ram 20 32k static memory 4k bound	375.00
GBT-R21	Godbout Ram 21 128K 8/16 bit static memory	995.00
CCS-2116	California Comuter 2116 16K static memory	335.00

DYNAMIC MEMORY BOARDS

CAL-D256	California Digital 256K dynamic memory 8 bit	495.00
SDS-EX3	SD Systems Expandoram III 256K dynamic	795.00
CCS-2065	California Computers 2065 64K dynamic	395.00
MSM-DMB64	Measurement Systems DMB6400 (Alpha Micro)	595.00

INTERFACE BOARDS

MDS-SW1	Morrow Designs Switchboard 2 serial 4 parallel	239.00
MDS-MLT1	Morrow Designs Multiboard 3 serial 2 parallel	275.00
GBT-133A	Godbout Interfacer I 2 serial ports	199.00
GBT-150A	Godbout Interfacer II 1 serial/3 parallel	199.00
GBT-135A	Godbout Interfacer III with 5 serial ports	495.00
GBT-138A	Godbout Interfacer III with 8 serial ports	585.00
GBT-187A	Godbout Interfacer IV 3 serial/2 parallel	295.00
CCS-2710	California Computer 4 port serial interface	295.00
CCS-2720	California Computer 2 serial / 2 parallel	295.00
CCS-2720	California Computer 4 port parallel	219.00

SPECIAL FUNCTION BOARDS

HYS-M100	D.C. Hayes Micromodem S-100 FCC approved	325.00
ADS-N100	Ackerman Digital Noisemaker with Votrax module	119.00
QTC-CC100	QT Computer clock calendar board	135.00
SCN-M100	Scion Microangelo graphics monochrome	965.00
GBT-SPC1	Godbout Spectrum 100 color video board	399.00
TEC-AD212	Tecmar A/D 12 bit accuracy 16 channel	485.00
GBT-SYS1	Godbout System support board	350.00
GBT-SYS9511	Godbout System Support with 8231/9511 math chip	539.00
MUL-TB1	Mullins extender board with test probe	79.00
MUL-ICB10	Mullins Opto-Isolator controls 8 channels	179.00
ADS-KG100	Ackerman Digital Kluge prototype board	149.00
IOT-W100	I/O Technology wire wrap prototype board	49.00
ART-WW100	Artec Electronics Wire wrap proto board	25.00
ART-GP100	Artec Electronics General purpose solder	25.00
CAL-MB18	California Digital 18 slot motherboard	35.00

256K DYNAMIC MEMORY BOARD

$495

- **256 kilobytes of memory using 64K dynamic RAM.**
- **Over one megabyte of memory using the new 256K dynamic RAM chips.**
- **Error detection-trap capability.**
- **Individual 16K block can be relocated to any boundry within a megabyte of RAM.**
- **24 bit addressing and phantom mode capability.**

The California Digital 256K RAM board represents an outstanding value in S-100 memory technology. Priced slighty above earlier generation 64K dynamic ram boards it gives you these additional features. 256K of memory with parity. Parity error feature can be jumpered to any of the interrupt lines, a status port, ERROR LED, or IEEE-696 *ERROR signal. 24 or 16 bit addressing with memory management.
Proper operation with front panel equipped systems, DMA disk controllers, and IEEE-696 Temporary Buss Masters assured with an on the board M1 generator for memory refresh timing. CAS and RAS timing is controlled with tapped digital delay lines for proper operation over the entire operating temperature range.
The board is very recent in design using the National Semiconductor DP-8409 RAM Controller chip. Split termination networks are used on all address lines, CAS line, and RAS lines eliminating the last traces of ringing. The board uses two separate voltage regulators. One for the DRAMs and one for the interface logic increasing the noise immunity of the ram array. Typical power dissipation is 8 watts.
Documentation includes theory of operation, configuration guide, a schematic, and application notes on the use of the memory management options. CAL-256K 2 Lbs.

VISA



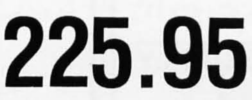
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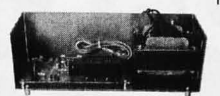


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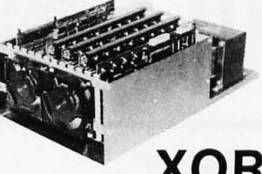
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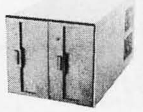


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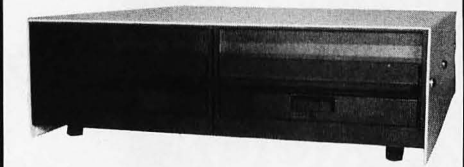
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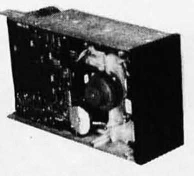
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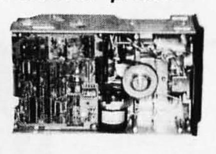
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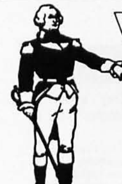
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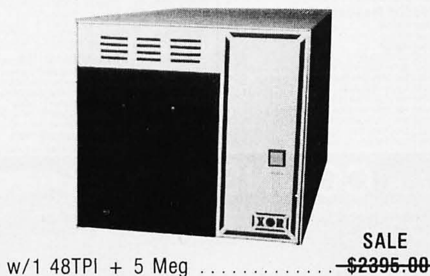
The 4 slot S-100 systems below are equipped with the **XOR** Z-80 4MHZ three board set. Each can run 8″ or 5″ disk simultaneously. In addition to the high speed **XOR** mini format, they can read KPRO, IBM and Morrow 5″ disk formats. Each has a modular dual power supply sub chassis. They are fan cooled. Standard IO is 2 serial ports and one centronics parallel. Expansion IO is available.

TWIN 5¼″ MINI



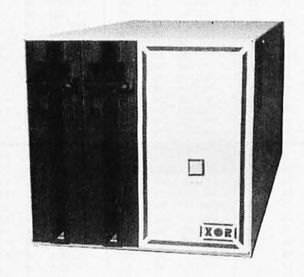
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5¼″ HARD DISK ★ NEW PRODUCT SPECIAL ★



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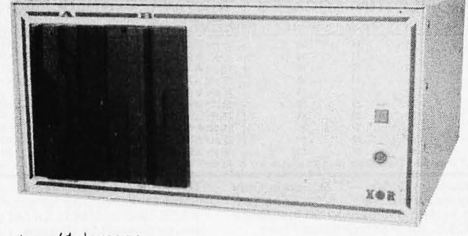
The 12 slot commercial grade S-100 systems below have all of the features listed above plus a massive 30 amp power supply capable of the expansion we expect you will do. All units are cooled by four inch fans. Each system must pass 2 days of constant read and write disk testing without a single error before shipment. ***One year complete system warranty is included.***

BASIC PROFESSIONAL



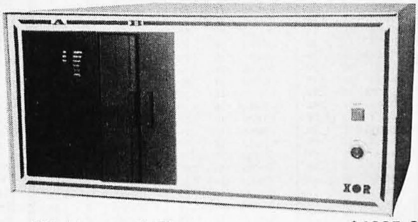
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SN7408N	14	.25
SN7409N	14	.25
SN7410N	14	.25
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SN74105N	14	.89
SN74107N	**14**	**.29**
SN74109N	**16**	**.39**
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.55
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.69
SN74142N	16	2.95
SN74143N	24	2.95
SN74144N	24	2.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59
SN74156N	16	.59
SN74157N	**16**	**.59**
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.79
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.89
SN74184N	16	1.95
SN74185N	16	1.95
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.89
SN74197N	14	.89
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	1.95
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	**Pins	Price
74LS00	14	.25
74LS01	14	.25
74LS02	14	.25
74LS03	14	.25
74LS04	14	.29
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	**14**	**.29**
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.35
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.39
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.65
74LS85	16	.69
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.49
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS151	16	.59
74LS153	16	.59
74LS154	24	.99
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.59
74LS175	16	.59
74LS181	24	2.49
74LS190	16	.89
74LS191	16	.89
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.09
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.29
74LS374	20	1.29
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

Part No.	**Pins	Price
74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S124	16	2.95
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	.99
74S175	16	.99
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	.79
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

Part No.	**Pins	Price
CA3010H		.99
CA3013H		2.15
CA3023H		3.25
CA3035H		5.95
CA3039H		1.35
CA3046N	14	.89
CA3059N	14	3.25
CA3060N	16	3.25
CA3080E	8	.89
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.19
CA3130E	8	1.49
CA3140E	8	.99
CA3160H		1.95
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

Part No.	**Pins	Price
CD4000	14	.29
CD4001	**14**	**.29**
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4009	**16**	**.39**
CD4010	16	.39
CD4011	14	.29
CD4012	**14**	**.15**
CD4013	14	.39
CD4014	16	.79
CD4015	**16**	**.39**
CD4016	14	.39
CD4017	16	.75
CD4018	16	.79
CD4019	16	.39
CD4020	16	.75
CD4021	16	.79
CD4022	16	.79
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.95
CD4035	16	.89
CD4040	16	.79
CD4041	14	.79
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.39
CD4049	**16**	**.39**
CD4050	16	.39
CD4051	16	.79
CD4052	16	.79
CD4053	16	.79
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	.89
CD4066	14	.39
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.79
CD4078	14	.49
CD4081	**14**	**.29**
CD4082	14	.29
CD4093	14	.49
CD4098	16	1.95
CD4506	16	1.19
CD4507	14	.39
CD4508	24	3.95
CD4510	16	.89
CD4511	16	.89
CD4512	16	.89
CD4514	24	1.79
CD4515	24	1.79
CD4516	16	.99
CD4518	16	.99
CD4519	16	.39
CD4520	16	.79
CD4528	16	1.19
CD4529	16	1.19
CD4543	16	1.19
CD4562	14	6.95
CD4566	16	1.59
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

(More in Catalog)

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	9.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Part No.	**Pins	Function	Price
Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-P10	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-P10	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-P10	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

Part No.	**Pins	Function	Price
MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

Part No.	**Pins	Function	Price
INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
DP82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	6.95
DP8304	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

Part No.	Description	Price
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	9.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	**16**	**4096x1**	**(250ns)**	**2.49**
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	**.49 — 8/1.95**
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

Part No.	**Pins			Price
1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	2.95
2114	18	1024x4	(450ns)	1.95 - 8/13.95
2114L	18	1024x4	(450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1	(150ns)	3.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	8.95
TMS4044	18	4096x1	(450ns)	3.95
TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	7.95
HM6116-4	24	2048x8	(200ns) CMOS	6.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	7.95
7489	16	16x4	(50ns) 3101	2.25
74C920	22	256x4	(250ns) CMOS (6551)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

Part No.	**Pins			Price
1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	6.95
TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
27580	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95

PROMS

Part No.	**Pins			Price
74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S478	24	1024x8	PROM T.S. (TBP28S86)	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	4.95
74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	3.95
82S129	16	256x4	PROM T.S. (27S21)	3.95
82S130	16	512x4	PROM O.C. (27S12)	5.95
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4	PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4	PROM T.S. (82S185)	9.95
DM87S190N	24	2048x8	PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8	PROM T.S. (82S191)	19.95

DATA ACQUISITION

Part No.	**Pins	Function	Price
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	18	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
AY-5-1013A	**40**	**30K Baud Uart (TR1602)**	**4.95**
1173AN-1	28	30-Tune Musical MPU w/specs.	6.95

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

Accessories

Part No.	Description	Price
DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$ .89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

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Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Professor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.

DT1057 — Expands the DT1050 vocabulary from 137 to over 260 words. Incl. 2 ROMs and specs.

DT1057 .... $24.95 ea.

RADIO CONTROL CIRCUITS

Ideal to use for:
- **Toys, hobby crafts, robots, trains**
- **Burglar alarms • IR data link**
- **Remote slide projector control**
- **Consumer remote data links**
- **Energy-saving, remotely switched lighting systems**

A complete 6-channel digital encoder and RF transmitter; low power, at frequency of 27MHz or 49MHz, a field strength of 10,000uV meter at 3 meters. 9V operation on chip RF oscillator/transmitter, on chip 4.6 regulator. Up to 80MHz carrier frequency operation.

LM1871N RC Encoder/Transmitter Chip . . . $1.95

A complete RF receiver/decoder, used at either 27MHz, 49MHz or 72MHz. It provides 4 independent channels when used with LM1871 (2 analog, 2 dig.) operates from four 1.5V cells, Crystal controlled.

LM1872N RC Receiver/Decoder Chip $2.49
SRX1504 49.435MHz Crystal (LM1872N) . . . $3.95
SRX1505 49.890MHz Crystal (LM1871N) . . . $3.95

INTERSIL

*Evaluation Kits

Part No.	**Pins	Function	Price
7045IPI	28	CMOS Precision Timer	14.95
7045EV/Kit*	28	Stopwatch Chip, XTL	19.95
7106CPL	40	3½ Digit A/D (LCD Drive)	9.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.	16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD.	15.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL	7.95
7208IPI	28	Seven Decade Counter	15.95
7209IPA	8	Clock Generator	3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL	14.95
7216AIJI	28	8 Digit Univ. Counter C.A.	29.95
7216CIJI	28	8 Digit Freq. Counter C.A.	24.95
7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

— AND MORE —

30009 1983 INTERSIL Data Book (1356p.) $9.95

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	5.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95

30012 1982 NATIONAL PAL Data Book (176p.) . . $5.95

74C—C/MOS

Part No.	**Pins	Price
74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19
74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	.79
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39
74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.39
80C97	16	.39

30001 1983 Nat. CMOS Book (628 pg.) $6.95

LINEAR

Part No.	**Pins	Price
TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	2.95
TL496CP	8	1.19
NE510A	14	4.95
NE529A	14	2.95
NE531V	8	2.95
NE536H		8.95
NE540H		4.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.89
NE570N	16	3.95
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LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	1.95
LM1800N	16	1.49
LM1889N	18	1.95
LM1896N	14	2.95
LM2002T		1.49
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	3.49
LM3915N	18	3.49
LM3916N	18	3.49
RC4136N	**14**	**1.25**
RC4151NB	8	1.95
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19

MORE AVAILABLE

30003 1982 Nat. Linear Data Book (1952 pgs.) . $11.95

Circle 244 on inquiry card.

Portable Speakers For "Walkman" Style Stereos

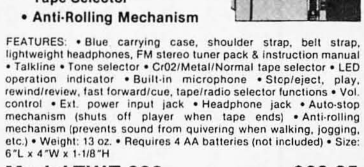


Portable Stereo Speakers with Carrying Case

After skating, skiing, jogging or any other outside activity, just plug these portable stereo speakers into your stereo and you and your friends can enjoy your favorite tapes reproduced by these full range speakers. Great for motel rooms, the beach, or in your car. They weigh just 3 lbs. and measure 5⅜"H x 4⅛"W x 2⅜"D. This unit uses 3" x 5" 8ohm speakers with a 3 oz. magnet. Speaker system includes two speakers, a carrying case, auxiliary speaker connector cable, and signal connector cable. Uses 8 "AA" batteries. Can be used with both portable stereos shown below, and is compatible with most mini-portable stereo cassettes and FM stereo units.

Part No. TSU-012 .... $29.95
AM3-8 8 AA Alkaline Batteries ...... 8 for $7.90

Stereo Cassette Player
with FM Stereo Tuner Pack



- Lightweight Headphones
- Cr02/Metal/Normal Tape Selector
- Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator • Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-rolling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weight: 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

Model TWF-802 .... $69.95
AM3-4 AA Alkaline Batteries .... 4/$3.95



CREDIT CARD AM/FM RADIO
World's Thinnest Stereo Hi-Fi

This is a pocketable AM/FM stereo radio with a folding stereo headphone. It weighs just 5 oz. and measures 4⅞"L x 2⅞"W x ⅛"Thk. Comes complete with radio, headphones and headphone case. Uses two AAA batteries (not included).

Part No. TCR-809 .... $29.95 each

JOYSTICKS



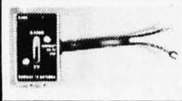
JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95

JS-5K (Pictured)

JS KNOB Knob for JS5K,100K,150K ..... $.99 ea.
JVC KNOB Knob for JVC-40 .... $.99 ea.

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ATARI PADDLES
JSP (2) .... $4.95 pair



TV GAME SWITCH
Used on Atari. Cosmetically blemished. 100% functional.

TGS-1 . . . $2.95 ea.

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30003	National Linear Data Book (1982) (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30005	National TTL Logic Data Book (1981) (624 pages) 7400,LS,L,H,S, and DM8000 Series	$9.95

30006 Above (3) 30001,3,5 as set . . $24.95

30008	National Memory Data Book (1980) (464 pages) RAMs, ROMs, PROMs, EPROMs Series	$6.95
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30012	National PAL Data Book (1982) (176 pages) Data Sheet, PAL Design	$5.95
30013	Zilog Data Book (1983) (641 pages) Microprocessors and Support Chips	$7.95
010400	Intel Component Data Book (1982) (1405 pg.) Full data sheets for Intel's products incl. mem. devices, microproc., periph. & ind./mil. products	$14.95
205610	Intel Peripheral Design Handbook (1981) (828 pages) Full data sheets, application notes for Intel peripheral device components	$9.95

Universal Computer Keyboard Enclosures

"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency. Rigid construction provides unlimited applications. Assembly instructions included.

PANEL WIDTH 3.40 8.50

DTE-8 Panel Width 7.5" $24.95
DTE-11 Panel Width 10.13" $27.95
DTE-14 Panel Width 13.5" $29.95
DTE-20 Panel Width 19.25" $34.95

KEYBOARDS — POWER SUPPLIES



DATANETICS 73-KEY KEYBOARD (ASCII) *Apple Compatible*
Data Entry Keyboard uses MM5740 BEE/N encoder chip (included). 73-Key Keyboard features 11-key numeric keypad, SPST switching, 24-pin edge card connection. Includes pin-out.
17⅞"L x 6"W x 1½"H
Part No. KB261 (Fits DTE-20 Enclosure) .... $49.95 each

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
23"Lx5¾"Wx1-3/8"H
Part No. 85SD18-1 .... $29.95 each

STACKPOLE 62-KEY KEYBOARD
SPST switching, mechanical, monolithic housing, charcoal grey keycaps. Keyboard is not mounted on circuit board (each key is individually accessible).
13"L x 3¾"W x 1½"
Part No. K-62 (Fits DTE-14 Enclosure) .... $34.95 each

HI-TEK 14-KEY NUMERIC KEYPAD
SPST switching. Charcoal grey keycaps, matches HI-TEK K-58 Keyboard (above). Mounted on printed circuit board.
3"L x 3"W x 1½"H
Part No. K-14 .... $9.95 each

ALPS 29-KEY CALCULATOR KEYBOARD
Features one 8-position decimal select switch, one 3-position switch, and two 2-position switches, mechanical SPST switching, 22-pin edge card connection. Pin-out included.
9⅞"L x 4½"W x 1⅞"H
Part No. KB297040 (Fits DTE-11 Enclosure) .... $4.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¼"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194 .... $19.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.
Part No. QPS-1 .... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94VO .... $49.95 each

POWER SUPPLY 4-Channel Switching - Apple Compatible
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line req.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A .... $69.95 each

POWER SUPPLY Adjustable Switching 4-24VDC to 5 Amps
Adj. 4-24VDC; 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ .5A. Overvoltage Protection. Input: 115VAC 50/60Hz. Output variations within 20mV. 8.25"L x 4.25"W x 2.25"H. Wt. 3.25 lbs.
JE224 Kit .... $79.95 each
JE224A Assembled & Tested .... $99.95 each

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers! *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102-12	14	single end	12"	$1.79
DJ14-2	924102-24	14	single end	24"	2.05
DJ14-3	924102-36	14	single end	36"	2.35
DJ14-1-14	924106-12	14	double end	12"	2.95
DJ14-2-14	924106-24	14	double end	24"	3.19
DJ14-3-14	924106-36	14	double end	36"	3.49
DJ16-1	924112-12	16	single end	12"	1.89
DJ16-2	924112-24	16	single end	24"	2.19
DJ16-3	924112-36	16	single end	36"	2.59
DJ16-1-16	924116-12	16	double end	12"	2.95
DJ16-2-16	924116-24	16	double end	24"	3.29
DJ16-3-16	924116-36	16	double end	36"	3.59
DJ24-1	924122-12	24	single end	12"	2.69
DJ24-2	924122-24	24	single end	24"	3.19
DJ24-3	924122-36	24	single end	36"	3.59
DJ24-1-24	924126-12	24	double end	12"	4.49
DJ24-2-24	924126-24	24	double end	24"	4.95
DJ24-3-24	924126-36	24	double end	36"	5.39

JAMECO Part No.	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ40-1	924132-12	40	single end	12"	5.39
DJ40-2	924132-24	40	single end	24"	6.19
DJ40-3	924132-36	40	single end	36"	6.89
DJ40-1-40	924136-12	40	double end	12"	9.49
DJ40-2-40	924136-24	40	double end	24"	10.29
DJ40-3-40	924136-36	40	double end	36"	10.95

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4-foot lengths. **Call today.**

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1-DB25P	$7.95
DB25S-4	4 feet	1-DB25S	8.49
DB25P-4-P	4 feet	2-DB25P	13.49
DB25P-4-S	4 feet	1-DB25P/1-DB25S	13.75
DB25S-4-S	4 feet	2-DB25S	13.95

BUG BOX™ — 30 individual compartments • Stores 60 8-pin or 30 14- or 16-pin DIPs • Bug rugs not included • Clear plastic cover slides & locks • Cover marked w/numbers 1-30 • Compartment size: 1" x 3.75" x .5" deep • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

BUG BOX™
Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	QTY	PRICE
BGX-001-( )	1	$ 2.29
BGX-010-( )	10	19.99
ANTI-STATIC		
BGX-001-( )AS	1	$ 3.29
BGX-010-( )AS	10	28.89

BUG CAGE™ — 12 locations store Bug Boxes, Big Bug Boxes or Bug Trays • Modular and interlocking • Heavy duty injection molded plastic • Each cage has 6 slip-on locations • 2 cages per pkg. • Cage size: 5-1/8" x 5" x 3-7/8" • 4 colors available — please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	Price
BGC-001-( ) 2 Cages (6 loc. ea.)	$11.95/pkg.

BUG TRAY™ — Stores in Bug Cage • Molded plastic • Three styles: Open (1 compartment 3.05" x 4.6" x .6"); Vertical (5 compartments .5" x 4.6" x .6"); and Horizontal (8 compartments .4" x 3.95" x .6") • Ideal for tools, hardware, components, etc. • Tray size: 3.55" x 5.05" x .6" • Black color only

PART NO.	DESCRIPTION	PRICE
BTH-001	Horizontal Bug Tray	$1.95
BTV-001	Vertical Bug Tray	1.95
BTO-001	Open Bug Tray	1.95
BTX-003	1 of each Bug Tray (3)	4.98

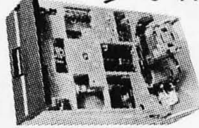
BUG RUG™ — Static discharge protection for CMOS and MOSFET devices • Pre-cut to dimensions of BUG BOX (1" x .35")

Part No.	Description	Price
BRG-030	30 foam rectangles for Bug Box	$1.98
BBR-036	6 foam rec. for LSI Big Bug Box	1.98

CAGE KEEPER™ — Pins column of Bug Boxes in Bug Cage

		Price
CKP-005	5 inch	$4.98/pkg.
CKP-010	10 inch	6.98/pkg.

BUG BOX™ STORAGE SYSTEMS



BUG CAGE™ (BGC-001-____) with Bug Boxes

LSI BIG BUG BOX™ — Designed to store large IC's, Resistors, Capacitors and Diodes • Divided into three compartments measuring 1" x 4.15" x .5" deep • Three vertical and three horizontal dividers included • Bug Rugs not included • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

LSI BIG BUG BOX™
Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

PART NO./COLOR CODE	QTY	PRICE
BLX-001-( )	1	$ 3.29
BLX-010-( )	10	28.79
ANTI-STATIC		
BLX-001-( )AS	1	$ 4.29
BLX-010-( )AS	10	37.89

BACK PACK™ — Self-adhesive labels for the back of ICs • Shows exact internal logic in relation to IC pins • 532 labels in each package (including several blank labels) • Each package for 8, 14, 16, 24, 28 and 40-pin ICs • Combo package includes 1,068 labels for TTL and CMOS ICs • Microprocessor package contains 744 labels

Part No.	Description	Price
BPT-012	TTL	$7.95
BPC-012	CMOS	8.95
BPM-012	Combo	14.95
BPU-012	Microprocessor	9.95

BUG TAGS™ — Self-adhesive, easy-to-read labels for marking Bug Box and LSI Big Bug Box • Most popular components

PART NO.	DESCRIPTION	QTY.	PRICE
BTT-200	TTL	200	$4.98
BTC-200	CMOS	200	4.98
BTK-200	LS Schottky	200	4.98
BTS-200	Special	200	4.98
BTM-800	Mixer	800	13.95

MORE BUG TAGS AVAILABLE!

★ ★ ★ BUG BOX SYSTEMS INTRODUCTORY SPECIAL ★ ★ ★

Your choice: regular or anti-static. Includes 2-Bug Cages (12 locations); 6-Bug Boxes; 3-LSI Big Bug Boxes; 1-horizontal Bug Tray; 1-open Bug Tray; 1-vertical Bug Tray; 1 package Bug Rug for regular Bug Boxes; 1 package Bug Rug for LSI Big Bug Boxes; 1 package Mixer Labels (800 each). Color: Bug Boxes and Cages - Blue, Bug Trays - Black.

SP-BUG Regular (Retail value $59.45) .... *Sale Price $49.95*
SP-BUG-AS Anti-Static (Retail value $67.45) .... *Sale Price $59.95*

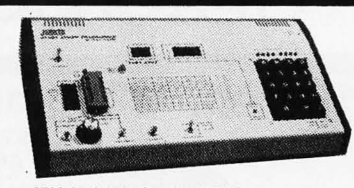
$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your
FREE 1983 JAMECO CATALOG
Prices Subject to Change



1355 SHOREWAY ROAD, BELMONT, CA 94002
5/83 ***PHONE ORDERS WELCOME — (415) 592-8097 Telex: 176043***

8K, 16K, 32K, 64K EPROM Programmer



2708,2716,2732 & 2764 EPROM Programmer

JE664 EPROM PROGRAMMER
8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES
Self-Contained — Requires No Additional Systems for Operation

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, ◄ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80* Model I, Level II Computer. Baud rate: 9600. Word Lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers.

JE664-ARS EPROM Prog. w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12, +12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM32C	2732A(21V)	Fujitsu, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95

Siemens 8" Floppy Disk Drive

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.		Price
FDD100-8	Buy 1 for	$269.95 each
FDD100-8	Buy 2 for	$259.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

5¼" Mini-Floppy Disk Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I (Industry Standard)
Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at right (does not incl. case, power supply, cables). 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.



Part No. *Limited Quantity!* Price
FD200 .... $179.95
Single-sided, 40 tracks, 250K bytes capacity
FD250 .... $199.95
Double-sided, 35 tracks, 438K bytes capacity

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K
**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required
— One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 each 4164-2 (200ns) 64K dynamic RAMs and conversion documentation. Converts TRS-80 color computers with D and E circuit boards, and all new color computers to 32K. Minor modifications of 32K memory will allow the use of all 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 .... $54.95

Sprite-style Fan

- 36cfm free air delivery
- 3.125" sq. x 1.665" depth
- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz

Metal Frame

PWS2107U Cleaned & tested (used) .... $ 9.95 ea.
*PWS2107F New .... $14.95 ea.

Muffin-style Fan



- 105cfm free air delivery
- 4.68" sq. x 1.50" depth.
- 10 yrs. cont. duty at 20°C
- Impedance protected, ambients to 70°C
- 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) .... $9.95 ea.
*MU2A-1N New .... $14.95 ea.

Mostek DC/DC Converter
+5 VOLTS TO -9 VOLTS



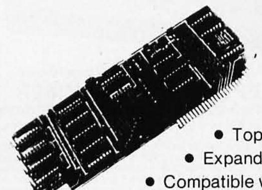
Input: +5V. Output: -9V (regulated) @ 30mA. Printed circuit mounting. *Specifications incl.*
DC10 ...... *$2.95 ea. or 2/$4.95*

Circle 244 on inquiry card.

ADVANCED COMPUTER PRODUCTS

SEND $2.00 for 1983 CATALOG

16K Apple™ Ramcard



LIST 195
ACP
$59^95

- Full 1 year warranty
- Top quality — gold fingers
- Expand Apple II 48K to 64K
- Compatible with Z-80 Softcard™

NEW FROM COEX
Apple IIe Compatible Extended 80 Column TEXT Card
List $199.00 — ACP $149.00

32K STATIC RAM

2 or 4 MHz Expandable Uses 2114L's

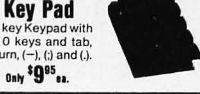
16K 4 MHz Kit	$159.95
16K 4 MHz A&T	217.95
32K 4 MHz Kit	$129.95 ~~289.95~~
• 32K 4 MHz A&T	• 339.00
BARE BOARD	39.95
Bare Bd w/all parts less mem.	99.95

64K CMOS RAMCARD

IEEE Compatible
Uses Low Power 6116 IC's
5Volt Single Supply
Assm and Tested

$299^00

REPEAT OF SELL-OUT 58 Key Unencoded Keyboard



$19^95 ea.

This is a new 58 key terminal Keyboard manufactured by a major manufacturer. It is uncoded with SPST keys unattached to any PC board. Solid molded plastic 11" x 4" base.

INTEL 4K STATIC RAMS

Super Fast! Super Low Power!

Part No. 2147 ...... **$1.95 ea.**

Unencoded Key Pad

15 key Keypad with 1-10 keys and tab, return, (–), (;) and (.).

Only $9^95 ea.

STEPPER MOTOR

Operates by applying 12VDC in one direction and then reversing polarity (or square wave). Uses 12VDC, Clock Wise Rotation, Rated 3 RPM at 4 P.P.S. with a 5 degree stepping angle.

ACP PRICE $3^95 ea. 10 for $34.95

UV "EPROM" ERASER

Model DE-4
$89.95
Holds 4 EPROM's at a time.
Model S-52T — $325.00

RS232 SIGNAL TESTER

COEX RS232 Line Tester
(7) LED Indicators
only $24^95
Other Styles Also Available

16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K
200/250nS
Specify computer — $12.95
CALL FOR VOLUME PRICING

INTEL CODEC IC

P/N 2910A
For Digital Voice
$9^95 ea.
For Filter P/N 2912A ... **$4.95 ea.**

CORCOM FILTER

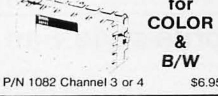


Popular CORCOM Filter
6 amps $4^95
Compatible Line Cord Add ... $3.50

SURGE SUPPRESSOR

"Surgeonics" Power Sentry
15 Amps 250 Volts transient suppression
ACP Low Price $39^95

Astec RF Modulator

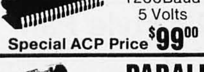


for COLOR & B/W
P/N 1082 Channel 3 or 4 — $6.95

CONNECTORS

DB25P (RS232)	$3.25
DB25S Female	3.75
Hood	1.25
Set with Hood, Sale	7.50
22/44 S/T, KIM	2.95
43/86 S/T, MOT	6.50
50/100 S-100 Connector W/W	4.95
50/100 S-100 Connector S/T	3.95

AMD MODEM IC



P/N AM7910
1200Baud
5 Volts
Special ACP Price $99^00

PARALLEL ALPHA NUMERIC PRINTER

19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or #. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit (schematic provided). Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 340mS. Size 6½"W x 3⅛"H x 5⅜"Dp. New. **$9.95 ea. 3/$27**

MICROPROCESSORS

Z8001	$99.00	8008-1	$14.95	6802P	14.95
Z8002	69.00	2901	9.90	8035	14.95
Z80	9.95	2901A	14.95	8039	12.95
Z80A	11.95	9900JL	49.95	8073N	34.95
F-8 (3850)	16.95	6502	9.95	8755	49.95
2650	16.95	6502A	16.95	8748	49.95
1802	9.75	IM6100	29.95	6809	30.00
8080A	4.75	6800	11.75	8086	49.95
8085	14.95	6800B	19.95	68000	129.95

RAMS

CALL FOR QTY PRICING

6116/2016	$7.95	2147	$5.99	5290	$1.99
8264-64K	5.95	411	5.99	5298	1.49
4116-2	1.99	414	4.69	6508	4.50
4116-2	8/12.95	1101	.99	6518	6.79
2101	3.99	1103	.99	6561	3.79
2102	.79	4027	4.69	6604	3.99
21L02-2	1.49	4044	3.99	6605	7.99
21L02-4	1.29	4050	4.69	9130	8.99
2111	3.49	4060	4.69	9140	8.99
2112	3.49	4096	3.99	93415	6.99
2114	1.99	4115	1:49	93425	6.99
2114L-2	3.25	4200	7.95		
2114L-4	2.29	4402	1.99		
2125	6.99	5280	4.60		

64K only $5.95

SUPPORT

8155	$9.95	8259	$8.95	68047	$22.95
8156	9.95	8275	19.95	68488	19.95
8202	29.95	8279	9.50	46505	22.95
8205	2.69	6810	4.75	6520	6.95
8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	6852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.50	6875	5.95	Z80-SIO	24.95
8257	9.50	6880	2.49	Z80A-SIO	29.95

MOS PROMS

2764 (8Kx8) TS	$69.95	2708 (450nS)	$5.75
2732 (4Kx8) TS	12.95	2708 (650nS)	5.25
2716/2516; 5V (2Kx8) TS	7.95	1702A	5.75
TMS2716, 5V, 12V	17.95	MM5203AQ	14.50
2758, 5V, (450nS)	3.50	MM5204Q	9.95

HI-TECH

2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024 VCO	2.95
MCM66740 Math Symbol	13.95	LM566 VCO	1.95
MCM66750 Alpha Control	13.45	XR2206 Function Generator	5.25
1771-01 8" & Minifloppy	24.95	TR1602B (5V, 12V)	3.95
1781 Dual Floppy	29.95	AY51013 (5V, 12V)	4.95
1791-01 Dual Floppy	36.95	AY51014A/1612 (5-14V)	6.95
1791-02 Dual Floppy	44.95	AY51015A/1863 (5V)	6.95
1793 DD, DS Floppy	44.95	IM6402	7.95
1797 DD, DS Floppy	54.95	IM6403	8.95
1691 Data Separator	18.95	2350 USRT	9.95
2143 Clock Generator	18.95	1671B Astros	24.95
8700 8 bit Binary	13.50	MC14411	11.95
8701 10 bit Binary	22.00	4702	14.95
8703 8 bit TS	13.50	WD1941	9.95
9400 Volt to Freq Conv.	7.25	COM5016	16.95
8750 3½ Digit BCD	13.95	INS8250	15.95
1408L6 6 bit	3.95	AY5-2376	13.75
1408L8 8 bit	5.95	AY5-3600	13.75
DAC01 D to A	5.95	MM5740AAC	8.95

SOCKETS

LOW PROFILE SOCKETS (TIN)

	1-24	25-49	50-100
8 pin LP	.16	.15	.14
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
40 pin LP	.60	.59	.58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.63	.58
14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
18 pin WW	.95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.53	1.38
40 pin WW	2.20	2.09	1.89

LINEAR

78H05K	$5.95	LM1414N	$1.90
78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	LM3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
LM340T-XX*	1.25	CA3082N	1.69
LM340H-XX*	1.25	CA3083N	1.55
LM344H	1.95	CA3086N	.80
LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	.98	LM3909N	.98
NE561T	19.95	LM3914N	3.75
NE565N/H	1.25	LM3915N	3.95
NE566H/V	1.75	LM3916N	3.75
NE567V/H	1.50	RC4131N	2.95
NE592N	2.75	RC4136N	1.10
LM702H	1.99	RC4151N	3.70
LM709N/H	.29	RC4194TK	4.95
LM710N/H	.75	RC4195TK	5.40
LM711N/H	.39	ULN2001	1.25
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7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
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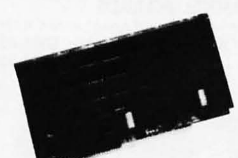
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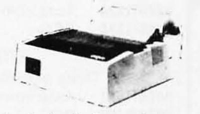
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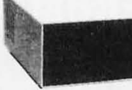
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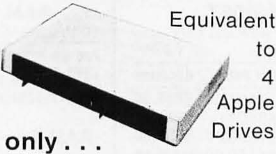
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Super Serial Card	195.00	169.00
Parallel Interface Card	165.00	139.00
80 Column Text Card	125.00	109.00
Extended 80 Column Text	295.00	249.00
Dot Matrix Printer	695.00	529.00

"Apple Products Available In-store Only"

MORE HARDWARE

	LIST	ACP
MICROSOFT		
Z80 Softcard	$395.00	$249.00
16K Ramcard	195.00	89.00
The Premium Package	685.00	654.00
SSM		
AIO-II 4 Function Serial/Parallel	225.00	179.00
AIO Serial/Parallel	195.00	165.00
EASTSIDE		
Wildcard Apple II	149.00	115.00
KENSINGTON		
System Saver	89.95	74.95
KEYBOARD COMPANY		
Numeric Keypad	149.95	124.95
Apple II Joystick	49.95	44.50
Apple II Handcontrollers	29.95	25.95
KRAFT (IBM also)		
Joystick		49.00
Hand Controller		40.00
MPC		
128K Bubble Memory	875.00	699.00
PROMETHEUS		
VERSAbox Spool/Buf'r	249.00	199.00
VERSAcard Four-in-1	199.00	166.00
AUTO-DOC diagnostics	99.00	82.00
VISTA COMPUTER CO.		
Vision 80 80x24 Card	395.00	219.00
Vision 80 Visicalc 80 Col Patch	69.00	49.00
A800 8" Disk Contr	379.95	349.00
Quartet Disk Drive 5¼"	849.00	799.00
Solo Disk Drive w/Contr	299.00	249.00
Solo Drive w/o Contr	379.00	319.00
Vista 5¼" Disk Contr	92.00	79.00
Typeahead Buffer	49.95	35.00
VIDEX		
Videoterm 80x24 Card	345.00	279.00
Keyboard Enhancer II	149.00	129.00
Soft Switch	35.00	30.00
Function Strip Keys	79.00	69.00
PRACTICAL PERIPHERALS		
16K Microbuffer	259.00	220.00
32K Microbuffer	299.00	253.00
Snapshot Option	149.00	109.00
VOTRAX		
Type n' Talk Speech	249.00	219.00
Personal System	395.00	339.00
VYNET		
Apple II Voice Syn.	395.00	349.00
Apple II Telephone I/O	295.00	249.00
SCOTT INSTRUMENTS		
Voice Recognit'n VET80	799.00	675.00
COEX		
16K RAM Card	99.00	59.95
Parallel Card w/cable	99.00	49.95
Apple Protocard	29.00	19.95
Apple Extendercard	29.00	19.95
Apple IIe Ext RAM Card	199.00	149.00
CORVUS		
5 Mb Hard Disk	3750.00	Call
10 Mb Hard Disk	5350.00	Call
20 Mb Hard Disk	6450.00	Call
ORANGE MICRO		
The Grappler I/O (Plus)	175.00	139.00
The Bufferboard	175.00	139.00
SATURN SYSTEMS		
32K RAM Card	219.00	179.00
128K RAM Card	499.00	439.00
SCOTT		
ECHO II	149.00	129.00
STREET		
ECHO II	149.00	129.00
LEGEND		
64KC II/IIe	327.00	269.00
128KC II/IIe	599.00	499.00
18SRC 18K Static	149.00	135.00
MOUNTAIN COMPUTER		
CPS Multifunction	239.00	169.00
Music System	395.00	335.00
A/D plus D/A	350.00	299.00
ROM Plus	155.00	129.00
M&R ENTERPRISES		
Sup'rterm 80x24 Card	395.00	269.00
Sup'rMod II	69.00	49.00
Sup'rMod V (IBM)	69.00	49.00
Sup'rAccess (New!)		Call
ALS		
The CP/M Plus Z80 card	399.00	319.00
Smarterm 80x24 Card	349.00	279.00
The Synergizer Package	699.00	549.00

16K RAM CARD



Apple II 16K
Compatible with
Z80 Softcard™ ... PASCAL CP/M™

Full 1 year Warranty. Top Quality by COEX

NEW LOW PRICE $59.95

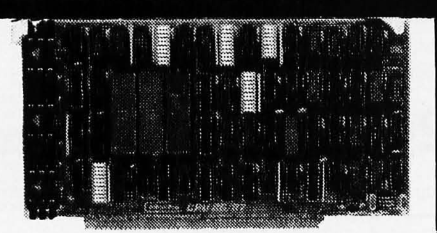
Also from COEX **NEW** EPSON Parallel Interface for Apple.
With cable.......... $49.95

TERMS: MO. Cashier's Check. Bank Wire. Personal checks allow 2 weeks for processing. Include Drivers License and credit card #s Visa, AMEX, CB add 3% service charge. Add 3% shipping & handling or $2.50, whichever is greater. Add 10% for foreign orders or US Parcel Post. Include Telephone number. NO CODs. Prices subject to change without notice. Some items subject to prior sale. We reserve the right to substitute manufacturer. Retail prices may vary.

Circle 16 on inquiry card.

THERE ARE NO BETTER BOARDS — THERE ARE NO BETTER PRICES!

CompuPro SYSTEMS FROM PRIORITY ONE ELECTRONICS



CPU BOARDS

CO-PROCESSOR 8086/8087

16 bit 8 or 10 MHz 8086 CPU with sockets for 8087 and 80130

Part No.	Description	List Price	Our Price
BQGBT186A	A&T 8MHz 8086 only	$750.00	$669.00
BQGBT186C	CSC 10MHz 8086 only	$850.00	$764.89
BQGBT186A87	A&T with 8087 option	$1050.00	$939.00
BQGBT186C87	CSC with 8087 option*	$1150.00	$1065.00

*8087 Limits clock speed to 5MHz

(816) DUAL PROCESSOR 8085-8088

6 or 8 MHz provides true 16 Bit Power with a standard 8 bit S-100 bus

BQGBT1612A	A&T 6MHz	$495.00	$439.00
BQGBT1612C	CSC 6/8 MHz	$595.00	$529.00

68K - 68000 16 BIT CPU

16 bit 8 or 10 MHz on-board sockets for 2716, 2732, or 2764 EPROMs for up to 8K x 16 of memory

BQGBT184A	A&T 8MHz	$695.00	$625.00
BQGBT184C	CSC 10MHz	$850.00	$765.00

FORTH OPERATING SYSTEM FOR 68K CPU

Requires a DISK 1, 64K of CompuPro memory, and an INTERFACER 3 or 4.

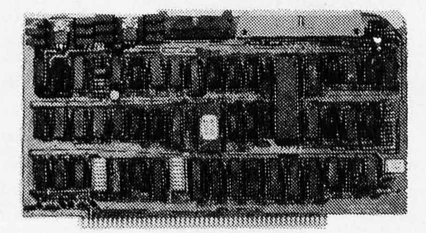
BQGBT68KOS	FORTH operating system		$200.00

CPUZ - Z80B CPU NOW 6MHz!

3/6 MHz Z80B CPU with 24 Bit Addressing. FASTEST Z80 CPU AVAILABLE!

BQGBT160A	3/6 MHz A&T	$325.00	$289.00
BQGBT160C	3/6 MHz CSC	$425.00	$379.00

DMA DISC CONTROLLER CP/M 2.2 FOR FREE!!*



When 2 or more 8" disk drives are purchased with Disk 1 Controller.

DISK CONTROLLERS

DISK 1 FLOPPY CONTROLLER - OUR BEST!

Fast DMA, Soft Sector, Controls Up to Four 8" or 5¼" Single or Double Density Drives.

BQPDB171ACPM	A&T w/CPM 2.2 & BIOS	$670.00	$495.00
	*When purchased with two 8" disk drives only.		$450.00
BQPDB171CCPM	CSC w/CP/M 2.2 & BIOS	$770.00	$595.00
BQGBT171A	Disk 1 Controller A&T	$495.00	$449.89
BQGBT171C	Disk 1 Controller CSC	$595.00	$550.00
BQGBTCPM80	CP/M 2.2 for Z80/8085 w/manual & BIOS 8" S/D disk		$174.89
BQGBTCPM86	CP/M 2.2 for 8086 w/manuals & BIOS 8" S/D disk.		$299.89

DISK 2/SELECTOR CHANNEL HARD DISK CONTROLLER

Fast DMA 2 board set. controls 4 Shugart 4000 series or Fujitsu 2300 type drives. Includes CP/M 2.2'

BQGBT177A	Assembled & Tested	$795.00	$750.00
BQGBT177C	CSC	$895.00	$850.00



CMOS RAM SALE!

RAM 17 - 64K CMOS STATIC RAM

12 MHz, RAM 17, 2 Watt, DMA Compatible 24 Bit Addressing

Part No.	Description	List Price	Our Price
BQGBT175A64	64K A&T 12MHz	$499.00	$460.00
BQGBT175C64	64K CSC 12MHz	$599.00	$550.00

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit
(816) 12 MHz, RAM 16, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt, 24 Bit Addressing

BQGBT190A	64K A&T 12MHz	$550.00	$510.00
BQGBT180C	64K CSC 12MHz	$650.00	$610.00



(816) NEW! RAM 21 - 128K STATIC RAM

816 RAM 21 12MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing

BQGBT190A	128K A&T	$1095.00	$ 995.00
BQGBT190C	128K CSC	$1245.00	$1125.00

M-DRIVE SOLID STATE DISK DRIVE, 3500% FASTER!!

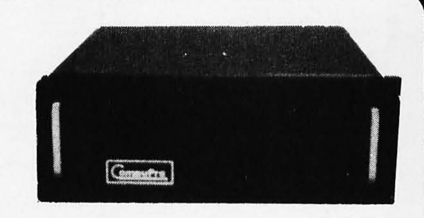
Not really, but the next best thing for CompuPro 8085/88 Users. Call for Details on M-Drive.
M-Drive requires a 6MHz CPU 8085/88 dual processor, Disk 1 DMA disk controller and System Support 1 Multifunction Board.

BQGBTMD128KA	128K of A&T memory & M-Drive Software	$1198.00
BQGBTMD128KC	128K of CSC memory & M-Drive Software	$1398.00
BQGBTMD256KA	256K of A&T memory & M-Drive Software	$2395.00
BQGBTMD256KC	256K of CSC memory & M-Drive Software	$2795.00

M-DRIVE/H HARDWARE LOGICAL DISK SYSTEM

Interfaces through two I/O ports, and runs at 10MHz. IEEE 696 compatible. Requires any CompuPro CPU and a Disk 1. Each board contains 512K of fast, low power (900mA) RAM, with parity checking.

BQGBT197A	M-DRIVE/H w/software, A&T	$1895.00	$1295.00
BQGBT197C	M-DRIVE/H w/software, CSC	$2095.00	$1495.00



S-100 MAINFRAME

110V 60Hz CVT Mainframe uses famous 20 slot CompuPro Motherboard (55 lbs.)

BQGBTENC20RM	20 Slot Rackmount	$895.00	$825.00
BQGBTENC20DK	20 Slot Desk Top	$825.00	$760.00

I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

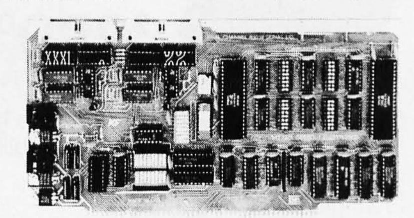
Serial port (software prog. baud), 4K RAM included, 15 levels of interrupt, real time clock, optional math processor

Part No.	Description	List Price	Our Price
BQGBT162A	Assembled & Tested	$450.00	$395.00
BQGBT162C	CSC	$550.00	$495.00
BQGBT8231	Math Chip		$195.00
BQGBT8232	Math Chip		$195.00
BQGBT162AM1	A&T w/8231 Math Chip		$570.00
BQGBT162CM1	CSC w/8231 Math Chip		$670.00
BQGBT162AM2	A&T w/8232 Math Chip		$570.00
BQGBT162CM2	CSC w/8232 Math Chip		$670.89

MPX CHANNEL BOARDS

I/O Multiplexer, using 8085A-2 CPU on board w/16K RAM

BQGBT166A16	Assembled & Tested	$649.00	$584.89
BQGBT166C16	CSC	$749.00	$674.89



INTERFACER 1

Two Serial I/O

BQGBT133A	Assembled & Tested	$295.00	$259.00
BQGBT133C	CSC	$370.00	$329.00

INTERFACER 2

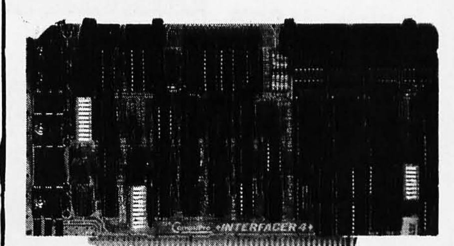
Three parallel, one serial I/O board

BQGBT150A	Assembled & Tested	$325.00	$289.00
BQGBT150C	CSC	$399.00	$359.00

INTERFACER 3

Eight-channel multi-user serial I/O board

BQGBT1748A	Assembled & Tested	$699.00	$628.89
BQGBT1748C	CSC 200 hr. 8 port	$849.00	$748.89
BQGBT1745A	Assembled & Tested	$599.00	$558.89
BQGBT1745C	CSC 200 hr. 5 port	$699.00	$628.89



INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BQGBT187A	Assembled & Tested	$450.00	$399.00
BQGBT187C	CSC	$540.00	$479.00

S-100 MOTHERBOARDS

Active termination, 6-12-20 Slot

BQGBT153A	A&T 6 slot, 2 lbs.	$140.00	$125.00
BQGBT153C	CSC 6 slot, 2 lbs.	$190.00	$155.00
BQGBT154A	A&T 12 slot, 3 lbs.	$175.00	$155.00
BQGBT154C	CSC 12 slot, 3 lbs.	$240.00	$220.00
BQGBT155A	A&T 20 slot, 4 lbs.	$265.00	$235.00
BQGBT155C	CSC 20 slot, 4 lbs.	$340.00	$310.00

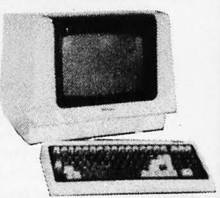
RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 368 on inquiry card.



WORLD'S BEST SELLING TERMINAL

Extra Memory Pages FREE!



BQPDBTLV9252P* $749.00
*TeleVideo 925 w/free 2nd page memory kit, a $95.00 Value!

BQPDBTLV9504P* $949.00
*TeleVideo 950 w/free 2nd, 3rd & 4th page memory kit,$285.00 value!

BQTLV910 $849.00
With emulations & foreign languages

(Shipping Weight 37 lbs.)

BEST BUYS!

1200 BAUD AUTO-DIAL

HAYES SMARTMODEM COMPATIBLE



MODEMS $495.00

The **AUTO DIAL 212A** Modem is a direct connect 0-300 or 1200 baud modem capable of dialing and calling for you. **The AUTO DIAL 212A is compatible in function to the DC Hayes SMARTMODEM™.**

Part No.	Description	List	SALE Price
BQUSRADIAL212A	0-300 1200 baud dialing modem	$599.00	$495.00

FREEDOM 50

LIBERTY ELECTRONICS

- 9 cursor control keys
- 7 editing function keys
- Programmable protection
- Multi-emulations
- Green screen 12″
- Tilt Base
- 5 function keys

BQLIBF50 (Sh. Wt. 34 lbs.)
List Price: $599.00

SALE PRICE: $475

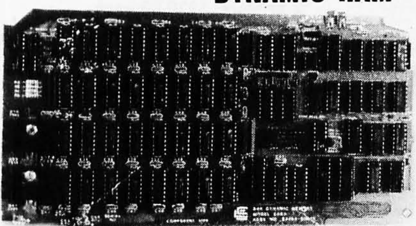
FREEDOM 100

Contains all of the above features of the FREEDOM 50 plus 5 additional function keys, 7 character sets, 15 special graphics symbols, and block mode transmission. **(Sh. Wt. 34 lbs.)**

BQLIBF100 List Price: $649.00 **SALE PRICE: $525.00**



64K IEEE/S-100 DYNAMIC RAM



2 or 4MHz BANK SELECTABLE

● 2 or 4MHz operation ● Designed to IEEE proposed S-100 bus standard ● Operates with either an 8080 or Z-80 based S-100 system providing processor transparent refreshes with both ● Bank-select system allows system memory expansion ● Any 16K block can be made bank-independent ● All 64K can be made bank-enabled on and reset ● Supports DMA ● Jumper-selectable Phantom input ● Assembled & Tested ● Uses Popular 4116 RAMs

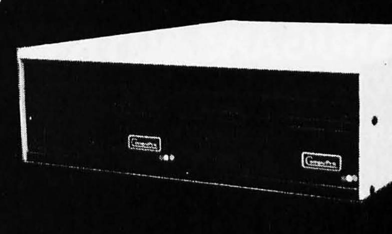
REGULAR LIST PRICE IS $375.00

$175.00 ea. 4/$640.00

BQCCS20653 (Sh. Wt. 2 lbs.)

DUAL QUME 8″ FLOPPY DRIVE, CABINET, DMA S-100 CONTROLLER, AND CP/M® FROM CompuPro

$1595.00
BQPDBGBTSYS206



YOU SAVE $1419.77!!

ABSOLUTELY THE MOST COST EFFECTIVE DISK SUBSYSTEM EVER OFFERED BY PRIORITY ONE ELECTRONICS!!

			List Price
• 2 Double sided 8″ QUME DT8 disk drives			
• DMA Floppy Controller (controls up to 4 drives)	1	GBT206SP	$2325.00
• CP/M® 2.2 w/bios written for the Disk 1 Controller	1	GBT171A	$495.00
• Cabinet includes power supply & internal data cable	1	GBTCPM80	$175.00
• External data cable included	1	PGC50S60S	$ 19.77
(Shipped freight collect)			$3014.77

CABINET AND 2 QUME DT8 DOUBLE SIDED DRIVES PROVIDE 2.4 MBYTES OF MASS STORAGE!! (Sh. Wt. 50 lbs.) **$1295.00**
List $2325.00 SAVE $1030.00! BQGBT206SP

CompuPro™ UN-SYSTEM 816

FOR THOSE WHO DEMAND EXCELLENCE!



Each CompuPro system contains the same nucleus of common hardware and software. This insures compatibility between systems as well as allowing you to expand as your needs grow. The following is a list of the basic hardware components as well as software.

HARDWARE:
- Desk top Enclosure 20 slots
- Floppy disk enclosure with 2 Qume DT8 drives
- DMA Floppy Controller
- 8085/8088 CPU operates 8 or 16 software
- Memory in the form of RAM 17s
- System support 1 (Clock calendar, RAM/ROM/math processor options, RS-232 Serial port, dual interrupt controllers, triple interval timers, and more!)
- All internal cables

SOFTWARE:
- CP/M 2.2™ and CP/M 86™
- M Drive Software - allows the use of memory as another disk drive
- Sorcim's SUPERCALC 86™
- Ashton Tate's DBase II

DIG DEEP!! Now is the time to buy the CompuPro UN-SYSTEM 816!!

SAVE MONEY, and have an UN-SYSTEM 816 for your very own! All UN-SYSTEMS contain the very same components as the SYSTEM 816s listed in our Winter 1983 Engineering Selection Guide, but are not installed or configured. All it takes is your professional computer experience and knowledge to have the highest performing S-100 computer system on the market today. BEWARE! This is not for the novice and inexperienced user, as it requires a well-matured knowledge in system integration procedures.

So, WHY WAIT!? Don't Pass Up This Incredible Deal!!

Each component of the UN-SYSTEM 816 has been assembled and individually tested. Final installation and configuration are the sole responsibility of the purchaser.

UN-SYSTEM 816/A

ENTRY LEVEL - SINGLE USER

Disk storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 128K - expandable to 1 Megabyte
Serial Ports: 4 / Parallel Ports: 1
Centronics/Epson ports: 1
Software: CP/M 2.2™, CP/M-86™, M-Drive, SuperCalc-86, dBase.
Component List Price: $6705.00 **BQGBTUNSYSA16**

OUR SALE PRICE: $4795.00 **SAVE $1910.00!!**

UN-SYSTEM 816/B

ENHANCED HIGH PERFORMANCE SINGLE USER SYSTEM

Disk Storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 256K - expandable to 1 Megabyte
Serial ports: 6
Software: CP/M 2.2™, CP/M-86™, M-Drive, SuperCalc-86™, dBase II™
Component List Price: $8497.00 **BQGBTUNSYSB16**

OUR SALE PRICE: $5795.00 **SAVE $2702.00!!**

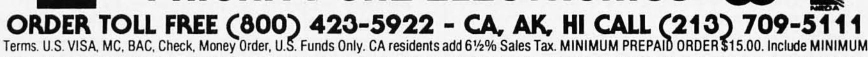
UN-SYSTEM 816/C

HIGH PERFORMANCE MULTI-USER SYSTEM

Disk storage: 2.4 Megabytes. Expandable to 4.8 Megabytes.
Main memory: 384K - expandable to 1 Megabyte
Serial ports: 9
Software: CP/M 2.2™, CP/M-86™, MP/M 8-16™, M-Drive, SuperCalc-86™, dBase II™
Component List Price: $10,636.00 **BQGBTUNSYSC16**

OUR SALE PRICE: $7595.00 **SAVE $3041.00!!**





PRIORITY ONE ELECTRONICS

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Terms. U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case, please include your phone number. Prices subject to change without notice. We will do our best to maintain prices through May, 1983. Credit Card orders will be charged appropriate freight. If you haven't received your Winter '83 Engineering Selection guide, send $1.00 for your copy today! Sale prices for prepaid orders only.

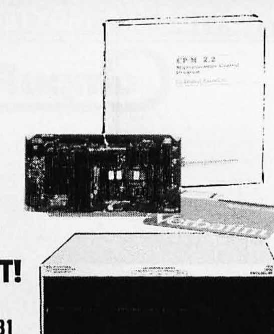
RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 368 on inquiry card.



S-100 DUAL 8" SUBSYSTEM

BQ CCS2422A	S-100 Disk Controller with CP/M 2.2	1	$399.00
BQ SIEFDD1008	Siemens Double Density 8" drive	2	$398.00
BQ IIIFDE002	Dual Horizontal Cabinet with Power Supply	1	$295.00
	and Data Cable	1	$ 35.00
			$1127.00



SAVE $132.00!!

$995.00

(Include $30.00 for shipping)

DON'T MISS OUT!
Order No.
BQ PDBSIESUB1

BUY DRIVE AND CABINET TOGETHER AND $AVE!

INTERNATIONAL INSTRUMENTATION, INC.



- Positive Pressure Filter Cooling
- Power Supply:4A@+5V,3A@+24V 1A@-5V
- Each output is individually fused
- Hinged top for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

DUAL 8" SIEMENS FDD1008, DUAL 8" CABINET POWER SUPPLY AND INTERNAL POWER CABLES

IF BOUGHT SEPARATELY: $890.00

PRICED AT: **$675.00**

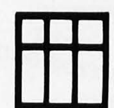
BPPDBIIISIE

ENVIRONMENT MONITOR PANEL

Temperature and voltage monitor with visual and audible alarm for overtemp condition. Direct Digital Readout of internal temperature in C° on standard DVM

BQ IIIFDE002	CABINET ONLY (Sh. Wt. 38 lbs.)	$295.00
BQ PDBIIISIEEM	2-Drives, Cabinet & disk environment monitor	$775.00
BQ IIIFDE002EM	Cabinet only with disk environment monitor	$375.00
BQ PDB50M18E18E	Dual Data Cable	$ 31.15
BQ PGC50S80S	External Data Cable	$ 19.77

OUR FINEST 8" DUAL DISK DRIVE CABINET

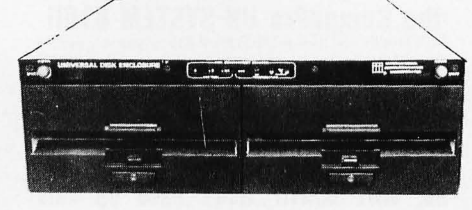


International Instrumentation Incorporated

Compare these features listed and you'll see why this cabinet is our

FINEST DISK CABINET

FEATURES
- Positive pressure forced air cooling for reliable disk drive operation
- AC input via 3 wire 7 foot international cord/socket set
- AC input EMI filtered to six amps to help prevent disk crashes due to power spikes and line noise
- 14 gauge main chassis
- Integral power supply with 5V @ 6A/-5V @ 1A/24V @ 6A
- Double-sided custom PC power board and supply
- Each DC supply and AC separately fused



STANDARD UNIVERSAL DISK ENCLOSURE

	List Price	OUR Price
BQIIIUDE004	$495.00	$425.00
With augmented power suply to handle Tandon Slimline, or Winchester disk drives. Includes the disk environment monitor.		
BQIIIUDE004AUG	$733.00	$625.00
With Disk Environment Monitor for cool, reliable operation.		
BQIIIUDE004EM	$584.95	$495.00



5¼" DISK DRIVES

BQMPI51*	Single-Sided Double-Density 48 TPI	$200.00
BQMPI52*	Double-Sided Double-Density 48 TPI	$270.00
BQMPI91*	Single-Sided Double-Density 96 TPI	$275.00
BQMPI92*	Double-Sided Double-Density 96 TPI	$400.00

**Replace "*" when ordering, with "m" for MPI style bezel, or "S" for Shugart style bezel. (Shipping Weight 5 lbs.)*

2" HIGH 8" DISK DRIVES



The first 2" high 8" disk drive allows for mounting under the keyboard on CRT, etc.
NO AC Required +5V +24VDC only
FAST 3 msec track to track!

BQ MPI41M	½ High 1 side double-density	$380.00
BQ MPI42M	½ High 2 side double-density	$460.00
BQ MPI41S	Full height 1 side single drive, dble.-density	$380.00
BQ MPI42S	Full height 2 sided single drive, dble.-density	$460.00
BQ MPI41D	Full height 1 side dual drive, dble.-density	$760.00
BQ MPI42D	Full height 2 side dual drive, dble.-density	$920.00

(Shipping Weight: 11 lbs. per drive)

Tandon



8-INCH THIN LINE

Exactly one-half the height of any other model
Proprietary, high-resolution, read-write heads patented by Tandon
D.C. only operation - no A.C. required
Industry standard interface
Three millisecond track-to-track access time (9 lbs.)

TANDON 8" DRIVES

BQTNDTM8481	Single Sided: $380.00	2 or more: $370.00 ea.
BQTNDTM8482	Double Sided: $495.00	2 or more: $485.00 ea.

TANDON 5¼" DRIVES

BQTNDTM1001	Single Sided, 250KB (5 lbs.)	$220.00 ea.
	2 or More: $200.00 each	
BQTNDTM1002	Double Sided, 500KB	$295.00 ea.
	2 or More: $270.00 each	
BQTNDTM1003	Single Sided, 500KB	$295.00 ea.
	2 or More: $270.00 each	
BQTNDTM1004	Double Sided, 1000KB	$395.00 ea.
	2 or More: $375.00 each	

DUAL 8" HALF HEIGHT FLOPPY CABINET

- 24V @ 4A 5V @ 3A -5V@ 800ma
- Fan cooled
- Socketed power connections
- All supplies regulated

INTERNATIONAL INSTRUMENTATION, INC.

	List Price	SALE
BQIIIDTL002 Dual Thin Line Cabinet (12 lbs.)	$225.00	$165.00

BUY THE CABINET & DRIVES AND $AVE!

With 2 Tandon Thinlines

BQPDBIIITND1 Cabinet w/2 TNDTM8481 -1 sided (30 lbs.)	$885.00
BQPDBIIITND2 Cabinet w/2 TNDTM8482 -2 sided (30 lbs.)	$1115.00

With 2 MPI Slimlines

BQPDBIIIMPI1 Cabinet w/2 MPI41M - 1 sided (30 lbs.)	$920.00
BQPDBIIIMPI2 Cabinet w/2 MPI42M - 2 sided (30 lbs.)	$1080.00

Options

BQIIIDTLMPIKIT MPI drive adaptor mounting kit (2 lbs.)	$24.95
BQIIIDCCSHU Shugart / AC/DC power connector kit (2 lbs.)	$14.95

(For full size single SA801 or compatible drives)

RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 369 on inquiry card.

PRIORITY ONE ELECTRONICS

SANYO

12" DATA DISPLAY MONITOR

24 Lines x 64 Characters



SAVE OVER 50% !!

BQSYODM2112 List Price: $160.00

SALE PRICE:

$75.00 !!

SAVE $85.00!!

(Sh. Wt. 16 lbs.)

LOWEST COST PRINTERS AVAILABLE

$299.00 !!

COEX 80 F/T by star micronics inc



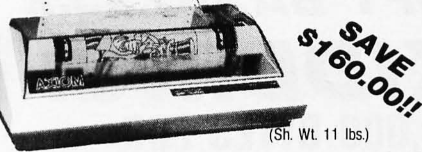
- 80 cps • 10, 12 or 16.5 cpi • 3 selectable line spacing • Vertical format control • Centronics parallel or RS232 serial interface • Uses a standard Underwood spooled ribbon • Friction and tractor feed

(Shipping Weight 21 lbs.)

		List Price	OUR Price
BQCOX80FT	Parallel int.	$399.00	$299.00
BQCOX80FTSER	Serial int.	$399.00	$329.00
BQCOXAPLINTP	Apple parallel interface w/cable		$49.95

$229.00





SAVE $160.00!!

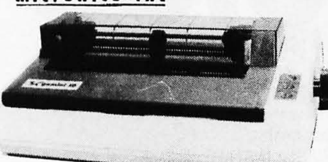
(Sh. Wt. 11 lbs.)

- 5 x 7 Dot Matrix • Parallel Interface (Centronics) • Tractor Feed • Dot Addressable Graphics • Up to 3-Part Paper • Self Test • One Year Warranty • 30 CPS 80 Column Unidirectional • Uses Regular Paper

BQAXMGP100A	Dot Matrix Printer	$389.00	$229.00

star micronics inc gemini-10

100CPS DOT MATRIX PRINTER



- Centronics parallel interface • 9 x 9 character matrix • 6 x 6 block graphic matrix • Bit image (7 or 8) x 480 dot matrix (single density) (7 or 8) x 960 dot matrix • Bi-directional printing with logic seeking • 40, 48, 66, 80, 96, or 132 characters per line • 96 ASCII characters • 5, 6, 8.5, 10, 12, or 17 characters per inch • 1/6, 1/8, n/72, n/144 Line pitch • Sprocket or friction feed • Uses a standard underwood ribbon

BQGEM10 80 Column* Printer List Price: $399.00

SALE PRICE: $359.00

(Shipping Weight: 20 lbs.)

BQGEM15 132 Column* Printer List Price: $649.00

SALE PRICE: $489.00

(Shipping Weight: 26 lbs.)

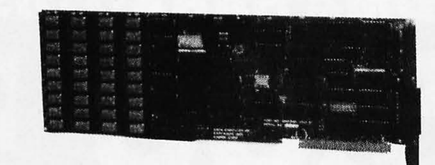
*Based on 10 characters per inch

SERIAL INTERFACE CARD FOR GEMINI 10 & 15

BQGEMSERINT Serial Interface Module (Sh. Wt. 1 lb.) **$85.00**

IBM® MULTICARD

Vista™ MEMORY & I/O CARD



- 64K RAM Expandable to 256K
- One RS232 Serial Port
- One Parallel Printer Port
- Real Time Clock Calendar with Battery Backup

(Sh. Wt. 1 lb.)

BQVIS025665 List Price: $595.00

SALE PRICE:

$399.00

IBM® MAXICARD

Vista PERSONAL COMPUTER RAM CARD

POPULATED IN 64K, 256K, or 576K



- Runs at full speed with no wait states
- Parity can be disabled at User's option
- On board parity bit on each Byte
- Fully expanded, a full 576KB on one card
- One board fills entire primary RAM address space available
- Full Vista 120 Day Warranty

64K $199.00
BQVIS057664 List Price: $379.00
SAVE $180.00

256K $449.00
BQVIS0576256 List Price: $789.00
SAVE $340.00

576K $950.00
BQVIS0576576 List Price: $1299.00
SAVE $349.00

*Available with 256K & 576K boards only (Sh. Wt. 6 lbs.)

(IBM is a trademark of International Business Machines)

EIA/RS232 WALL PLATES

(Does not include connectors)

BQIIIWPDB251 Single punched

4/$10.00

BQIIIWPDB252 Dual Punched

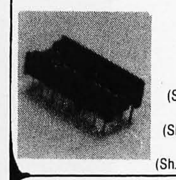
4/$12.00

RS-232 "D" SUB-MINIATURE CONNECTORS

		1-9	10-24	25-99	100-UP
BQCNDDB25P	25 Pin Male	$2.75	$2.50	$2.25	$1.95
BQCNDDB25S	25 Pin Female	$4.00	$3.50	$3.25	$3.00
BQCNDDB51212	1 Pc. Grey Hood	$1.65	$1.40	$1.25	$1.15
BQCNDP25H	2 Pc. Grey Hood	$1.50	$1.25	$1.10	$1.00
BQCNDDB51226	2 Pc. Black Hood	$1.75	$1.50	$1.35	$1.20
BQCNDD20418	Hardware set 2/Pr.	$1.00	$ .80	$ .70	$ .60

TEXAS INSTRUMENTS

16 PIN GOLD AND TIN DIP SOLDERTAIL SOCKETS



QTY	TIN BQTIS16LP	GOLD BQTIG16LP
50 (Sh. Wt. 4 oz.)	$ 8.00	$ 10.00
1000 (Sh. Wt. 4 lbs.)	$ 60.00	$ 80.00
4500 (Sh. Wt. 15 lbs.)	$225.00	$315.00

DIRECT CONNECT MODEM

$79.00 MURA

0 - 300 BAUD MURA MM-100

NEW!

- 0 - 300 baud
- RS232C interface
- Full duplex
- Carrier detect indicator
- Bell 103 compatible
- Low voltage
- Originate/Answer switch selectable

		List Price	SALE
BQMURMM100	0 - 300 baud modem (Shipping Weight: 2 lbs.)	$99.95	$79.00
BQCNDRS2328F	RS232 cable		$19.95

ULTRA MAGNETICS 5¼" FLOPPY DISKETTES

LIFETIME WARRANTY!

DOUBLE DENSITY!

FEATURES:

- Includes reinforcement ring
- Write protect with tabs
- 100% Surface tested
- Lifetime warranty

SALE!

SINGLE SIDED

40 TRACKS — DOUBLE DENSITY

ORDER INFORMATION:

BQULT51401 Soft Sector
BQULT51410 10 Sector
BQULT51416 16 Sector

BOX OF 10 **$25.00**
2 BOXES: **$40.00**
10 BOXES: **$180.00**

Description		Box of 10	2 Boxes	10 Boxes
BQULT52401	Soft sector, 40 track, 2 side	$35.00	$60.00	$280.00
BQULT52410	10 sector, 40 track, 2 side			
BQULT52416	16 sector, 40 track, 2 side			
BQULT51801	Soft sector, 80 track, 1 side	$30.00	$50.00	$220.00
BQULT51810	10 sector, 80 track, 1 side			
BQULT51816	16 sector, 80 track, 1 side			
BQULT52801	Soft sector, 80 track, 2 sided	$40.00	$70.00	$320.00
BQULT52810	10 sector, 80 track, 2 sided			
BQULT52816	16 Sector, 80 track, 2 sided	(Sh. Wt. 2 lbs)	(Sh. Wt. 4 lbs.)	(Sh. Wt. 20 lbs.)

VISA







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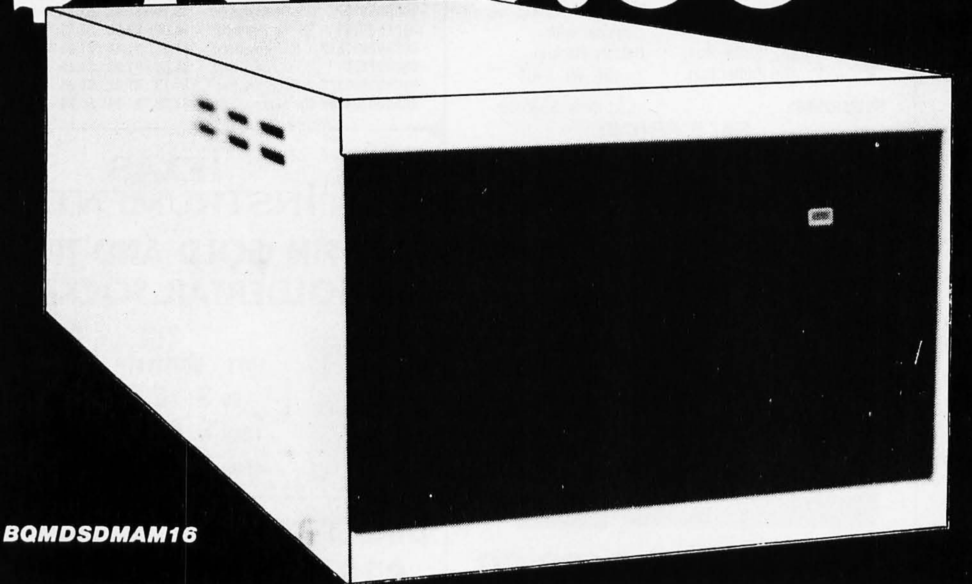
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Circle 369 on inquiry card.





SAVE OVER 45% !!

There are price barriers to be broken, and then there are PRICE BARRIERS TO BE ***S-H-A-T-T-E-R-E-D!!*** Priority One Electronics prides itself on breaking price barriers — but never like the one you see here! We're talking about 16 ***M-E-G-A-B-Y-T-E-S*** FOR ONLY ***$1595.00***!!

That's the storage capacity of THIRTY TWO Shugart SA801Rs — at one tenth the price! And there can be no comparisons between the performance of this system and floppy disk drives!

PURE SPEED

That's what you get when you operate this subsystem. Imagine data access virtually without wait! By using DMA technology, the actual time required to send and retrieve data is greatly reduced. With the additional speed and high density of the 5¼" Winchester disk drive from COMPUTER MEMORIES, you will have enormous files at your own fingertips without the frustration of searching for the right floppy disk! The throughput of this subsystem is further increased by having all low level disk drive routines resident on the DMA controller, thus relieving the computer for other tasks.

COMPATIBILITY

MORROW DESIGNS engineers have invested thousands of man-hours to assure that this M16 hard disk subsystem will be compatible with almost all S-100 IEEE/696 computer systems. Each M16 hard disk subsystem is supplied with CP/M 2.2™, and MICROSOFT BASIC V5.2™. **MORROW DESIGNS** has even included an INSTALL program on 8" disk so you can easily custom configure your M16 subsystem to operate flawlessly with any system that is fully IEEE/696 compatible and has no other DMA devices on line. North Star compatible INSTALL package available by special order.

EXPANDABLE

The M16 subsystem can grow with your needs. The DMA controller can operate up to four drives at one time. Just imagine — 64 MBytes on line! Also, as technologies progress, you will be prepared with a controller designed with the future in mind!

KEY FEATURES:

DISK DRIVE:
- DISCUS M16: Computer Memories CMI5616, 16Mb formatted capacity
- Same physical size and mounting as the minifloppy
- Same DC voltages as the minifloppy
- Band actuator and stepper motor head positioning
- 5.0 megabit/second transfer rate
- Same track capacity as a double density 8 inch floppy
- 170 millisecond random average access time, reduceable to 95 ms via a simple software algorithm

CONTROLLER:
- Fully compatible with high speed 6MHz and 8 MHz CPUs of today and tomorrow
- DMA bus arbitration as outlined by the IEEE 696 standard
- Controls 1 to 4 soft sectored Winchester drives
- Variable sector length (256, 512, 1024, or 2048 byte sectors)
- Automatic CRC generation and checking
- Addresses 1 to 16 heads
- Addresses an infinite number of tracks
- 24-bit address burst DMA transfers
- Due to this high transfer rate, a minimum CPU speed of 2.5MHz is required

WITH CP/M 2.2™ AND MICROSOFT BASIC V5.2™

NO KIDDING!

16,000,000 BYTES FOR

ONLY $1595.00

LIST PRICE: $2995.00 (Shipping Weight 20 lbs.)

SAVE $1400.00!!

BQMDSDMAM16 16 MB Subsystem
BQMDSDMAM16NS With NorthStar INSTALL package

DON'T WAIT!!!

WE HAVE PURCHASED ANOTHER PRODUCTION RUN — AS WE SOLD OUT THE LAST ONE IN LESS THAN A MONTH!!

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LAST CHANCE FOR SCOPE REBATE!!

B+K PRECISION DYNASCAN CORPORATION

BKP1535 SPECIFICATIONS

• 35MHz response; useable beyond 50MHz • 2 mV/cm vertical sensitivity • Signal delay line for accurate view of high frequency pulse leading edge • Alternate trigger capability • Automatic or manual selection of CHOP AND ALTERNATE dual-trace display • Variable hold-off for accurate pulse train display • Video sync separators standard • Built-in triggering filters • PDA CRT with P31 phosphor • 10:1/ref/direct probes included • Differential input capability

35 MHz
DUAL TRACE - TRIGGERED
BQBKP1535 List Price: $950.00

$695.00
(Shipping Weight 20 lbs.)
SAVE $330.00!!
INCLUDING REBATE

$75.00 REBATE!



(Valid through 6/30/83)

DIRECT FACTORY CONSUMER REBATE CERTIFICATE INCLUDED!

$50.00 REBATE!

B+K PRECISION DYNASCAN CORPORATION

BKP1530 SPECIFICATIONS:

• Delayed sweep operation for sweep expansion up to 1000V • 5 mV division sensitivity selectable 2 mV to 20MHz • Variable hold-off pulse train display • Single-sweep for nonrepetitive waveforms • Built-in triggering filters • Video sync separator standard • CHOP or ALTERNATE display • Differential input capability • 11.7 nS rise time for short duration pulses • Alternate trigger capability • Front panel x-y operation • 10:1/reference/direct probes included

30 MHz
DUAL TRACE - DELAYED SWEEP
BQBKP1530 List Price: $875.00

$625.00
(Shipping Weight 20 lbs.)
SAVE $300.00!!
INCLUDING REBATE

TAXAN

12" RGB COLOR MONITOR

380 HORIZONTAL LINE RESOLUTION



BQTAXRGB1
List Price: $399.00
(Sh. Wt. 29 lbs.)

$329

BQTAXIBMRGB
Interface cable to IBM **$19.00**

BQTAXRGBAPL
Apple IIe & III cable **$19.00**

WITH APPLE II RGB INTERFACE
BQPDBTAXRGBAPL
List Price: $528.00 **$359.00**

12" RGB SUPER HIGH RESOLUTION MONITOR

630 HORIZONTAL LINE RESOLUTION

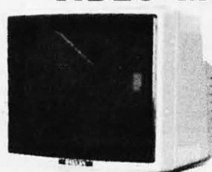
- 18MHz bandwidth
- Linear RGB input provides unlimited color combintations
- Compatible with APPLE III and IBM P/C

BQTAXRGB3
LIST PRICE: $699.00
(Sh. Wt. 29 lbs.)

SALE PRICE: $595.00

SUPER HIGH RESOLUTION RGB MONITOR WITH AN APPLE INTERFACE CARD
BQPDBRGB3APL $695.00

HIGH RESOLUTION 12" GREEN OR AMBER VIDEO MONITOR



- >18 MHz bandwidth
- 800 line horizontal resolution
- Composite video input

BQTAXKG12N Green
BQTAXKG12NUY Amber
LIST PRICE: $179.00
(Shipping Weight 19 lbs.)

SALE PRICE: $129.00



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SERIES 10 Programmable Calculators

- RPN Logic
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- Automatic Turn-off Function
- LCD
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Part No.	Description	List Price	SALE PRICE
BQ HP-10C	Scientific (Shipping Weight 3 lbs.)	$ 70.00	$59.00
BQ HP-11C	Advanced Scientific (Shipping Weight 3 lbs.)	$ 90.00	$79.00
BQ HP-12C	Advanced Financial (Shipping Weight 3 lbs.)	$120.00	$99.00
BQ HP-15C	Advanced Scientific w/matrices (Sh. Wt. 3 lbs.)	$120.00	$99.00
BQ HP-16C	For Digital Electronics & Computer Science (3 lbs.)	$120.00	$99.00

HP-41C/CV - Handheld Computer System

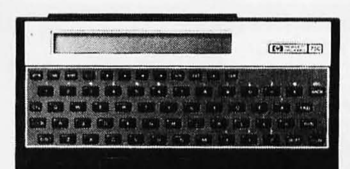


Part No.	Description	List Price	SALE
BQ HP-41C	Handheld computer w/HP821061 memory module included (5 lbs.)	$195.00	$159.00
BQ HP-41CV	Handheld Computer w/5X Memory (5 lbs.)	$275.00	$219.00
BQ HP82104A	Plug-in Card Reader (Sh. Wt. 5 lbs.)	$195.00	$159.00
BQ HP82153A	Optical Wand (Sh. Wt. 5 lbs.)	$125.00	$ 99.00
BQ HP82161A	Digital Cassette Drive (Sh.Wt. 5 lbs.)	$450.00	$349.00
BQ HP82162A	Thermal Printer/Plotter (Sh. Wt. 5 lbs.)	$450.00	$349.00
BQ HP82163A	Video Interface (Sh. Wt. 5 lbs.)	$225.00	$179.00

ENHANCEMENT MODULES:

BQ HP82160A	HP-IL Module	$125.00	$95.00
BQ HP82170A	Quad RAM	$ 75.00	$59.00
BQ HP82180A	Extended Functions/Memory Module	$ 75.00	$59.00
BQ HP82181A	Extended Memory Module	$ 75.00	$59.00
BQ HP82182A	Time Module	$ 75.00	$59.00

HP-75C PORTABLE COMPUTER



- Accepts 48K of applications ROM
- Touch-type typewriter-like keyboard
- Powerful BASIC Language
- Uses same peripherals as Series 40

BP HP-75C (Sh. Wt. 9 lbs.) List: $995.00

SALE PRICE $795.00



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Circle 370 on inquiry card.

4164 64K DYNAMIC 200 NS $5.95

TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.49
2111	256 x 4 (450ns)	2.49
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114L-4	1024 x 4 (450ns) (LP)	8/12.95
2114L-3	1024 x 4 (300ns) (LP)	8/13.45
2114L-2	1024 x 4 (200ns) (LP)	8/13.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.75
HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
UPD411	4096 x 1 (300ns)	3.00
MM5280	4096 x 1 (300ns)	3.00
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/12.95
4116-150	16384 x 1 (150ns)	8/14.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
4164-200	65536 x 1 (200ns) (5v)	5.95
4164-150	65536 x 1 (150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
2764	8192 x 8 (450ns) (5v)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95
6.0 Mhz	
Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95
ZILOG	
Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8231	call
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	14.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	.99
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	.99
74LS113	.39	74LS374	.99
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	81LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

JDR Microdevices

1224 S. Bascom Avenue
San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA)
(408) 995-5430 • Telex 171-110

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Circle 245 on inquiry card.

Circle 245 on inquiry card.

2732 32K EPROM $4.95   2764 64K EPROM $9.95

CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V	50V
.22uf						.40	
.27						.40	
.33						.40	.45
.47				.35			.50
.68						.45	.50
1.0			.40	.40	.45	.45	
1.5				.45		.50	.60
1.8							.75
2.2		.35	.40	.45		.65	.85
2.7		.40	.45				.90
3.3		.45	.50	.55	.60	.65	.90
3.9		.45					
4.7	.45	.55		.60	.65	.85	.90
6.0			.60				
6.8			.70		.75		
8.2							1.00
10	.55	.65	.80	.85	.90	1.00	
12	.65		.85	.90			
15	.75	.85	.90				
18			1.25				
22		1.00	1.35				
27			2.25				
39		1.50					
47	1.35						
56	1.75						
100		3.25					
270	3.75						

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

.1uf-mono	50V	.18	.47uf-mono	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			1500	16V	.70
			6000	16V	.85

COMPUTER GRADE

26,000uf 30V 3.95

WIREWRAP CARDS

FR-4 Epoxy Glass Laminate
With Gold-Plated Contact Fingers

S-100 BUSS

P100-1	Bare — No Foil Pads	15.95
P100-2	Horizontal BUSS	22.95
P100-3	Vertical BUSS	22.95
P100-4	Single Foil Pads Per Hole	23.95

APPLE

P500-1	Bare — No Foil Pads	15.95
P500-3	Horizontal BUSS	22.95
P500-4	Single Foil Pads Per Hole	23.95

IBM

IBM-PR	BUSS Lines + Pads	55.00

GENERAL PURPOSE

22/44 PIN (.156" SPACING)

P441-3	Vertical BUSS, 4.5" x 6"	13.95
P442-3	Vertical BUSS, 4.5" x 9"	14.95

36/72 PIN (.1" SPACING)

P721-3	Vertical BUSS, 4.5" x 6"	13.95
P722-3	Vertical BUSS, 4.5" x 9"	14.95

IF YOU CAN FIND A PRICE LOWER ELSEWHERE, LET US KNOW AND WE WILL MEET OR BEAT THEIR PRICE! (SEE TERMS BELOW)

OPTO-ISOLATORS

4N26	1.00	MCA-7	1.50
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55

MUFFIN FANS NEW UN-USED

4.68" Square	14.95
3.125" Square	14.95

SWITCHES

SPDT mini-toggle	1.25
DPDT mini-toggle	1.50
SPDT push-button	1.49

TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.50	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

HEAT-SINKS

TO-3 style	.95
TO-220 style	.35

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.08
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.49	.49
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW = WIREWRAP

16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call

ZIF = TEXTOOL
(Zero Insertion Force)

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

MasterCard

VISA

LED LAMPS

	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

BYPASS CAPS

.01 UF DISC	100/6.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

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Circle 246 on inquiry card.

2716 16K EPROM $3.95 TMS2532 32K EPROM $5.95

MICROCOMPUTER HARDWARE HANDBOOK

FROM ELCOMP — $14.95

ver 800 pages of manufacturers data
ieets on most commonly used IC's.
cludes:
TTL — 74/74LS and 74F
CMOS
Voltage Regulators
Memory — RAM, ROM, EPROM
CPU's — 6800, 6500, Z80, 8080, 8085, 8086/8
MPU support & interface — 6800, 6500, Z80, 8200, etc.

BEST SELLING BOOKS

OSBORNE/MC GRAW-HILL

Apple II User's Guide	16.95
CRT Controller's Handbook	9.95
68000 Assembly Language Programming	16.99
CBASIC User Guide	15.00

SYBEX

Your First Computer	8.95
The CP/M Handbook	14.95
The PASCAL Handbook	18.95
Microprocessor Interfacing Techniques	17.95

TRANSFORMERS

FRAME STYLE

.6VAC	2amp	4.95
.6VAC CT	2amp	5.95
.6VAC CT	4amp	7.95
.6VAC CT	8amp	10.95
.2VAC CT	2amp	7.95

PLUG CASE STYLE

VAC	250ma	3.95
VAC	500ma	4.95
VAC	1amp	5.95
VAC	2amp	6.95

DC ADAPATER

9, 12 VDC selectable with universal adapter 8.95

OTE: Please include sufficient amount for ipping on above items.

DISK DRIVES

TANDON

TM100-1 5¼" (FOR IBM) SS/DD	229.00
TM100-2 5¼" (FOR IBM) DS/DD	295.00

SHUGART

SA 400L 5¼" (40 TRACK) SS/DD	199.95
SA 400 5¼" (35 TRACK) SS/DD	189.95

SIEMENS

FD100-8 8" SS/DD (801 REPLACEMENT)	259.00

PERTEC

FD-200 5¼" SS/DD	179.95
FD-250 5¼" DS/DD	199.95

MPI

MP-52 5¼" (FOR IBM) DS/DD	295.00

NOTE: Please include sufficient amount for shipping on above items.

CABINETS FOR 5¼" DISK DRIVES

CABINET #1 $29.95

★ DIMENSIONS 8⅝ x 5^{15}/$_{16}$ x 3^{15}/$_{16}$"
★ COLOR MATCHES APPLE
★ FITS STANDARD 5¼" DRIVES, INCL. SHUGART
★ INCLUDES MOUNTING HARDWARE AND FEET

CABINET #2 $79.00

★ COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
★ DIMENSIONS: 11½ x 5¾ x 3^{15}/$_{16}$"
★ +5V @ 1 AMP, +12V @ 1.5 AMP
★ FITS STANDARD 5¼" DRIVES
★ PLEASE **SPECIFY** GRAY OR TAN

NOTE: Please include sufficient amount for shipping on above items.

JDR SPRING SPECIALS

SA400 $189.95

★ 35 TRACKS
★ REPEAT OF A SELLOUT
★ LIMITED SUPPLY (AGAIN)
★ MODIFY FOR USE IN APPLE (EXPERIENCED TECHNICIANS)
★ USE WITH CABINET #1 TO MAKE A BEAUTIFUL APPLE COMPATIBLE DRIVE

MODIFICATION INSTRUCTIONS $1.00
34 PIN EDGE CARD CONNECTOR MATES TO RIBBON CABLE $3.25

MEMORY SALE

2114 450NS (TMS4045)	8/9.95	100 FOR .99 ea.
2114 250NS (TMS4045)	8/10.95	100 FOR 1.99 ea.
2102L-4 LOW POWER 450NS	.55 ea.	100 FOR .49 ea.

4164 200NS	5.95	Z80A-CPU 4MHZ	4.95
HM6116-4 200NS	4.75	8080 2MHZ	3.95
TMM2016 200NS	4.15	8085 3MHZ	5.95
2732 450NS	4.95	8086 5MHZ	29.95
TMS2532 450NS	5.95	6800 1MHZ	3.95
2764 450NS	9.95	68000 8MHZ	59.95

COMPONENTS

LM1488 or LM1489 .69 ea. 7805T or 7812T .75 ea.
16 PIN LOW PROFILE ST IC SOCKETS 100/8.00
16 PIN TOOLED WIRE WRAP IC SOCKETS .49 EA.

SPRING SPECIALS ARE GOOD ONLY UNTIL MAY 31, 1983

POWER SUPPLY

MODEL 2 $39.95

MOUNTED ON PC BOARD
MANUFACTURED BY CONVER

+5 VOLT 4 AMP
±12 VOLT 1 AMP

NOTE: Please include sufficient amount for shipping on above items.

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95
44 pin ST	2.95
44 pin WW	4.95
72 pin ST	6.95
72 pin WW	7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
20	.65	5.70	1.25	11.00
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER		RIGHT ANGLE SOLDER		RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	—	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	—	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	—	2.95
50	6.06	9.24	—	—	—	—	—	3.50

For order instructions see "IDC Connectors" below.

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	—	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

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Unclassified Ads

FOR SALE: Three Teletype Model 43 teleprinters (all with upper/lowercase) and three Texas Instruments Model 745 portable teleprinters. Two Model 43s have RS-232C and 20-mA current loop interfaces; one has modem. The TI Model 745s are Silent 700 with built-in modems, RS-232C serial parts, and 20-mA current loop. All systems are approximately 1-2 years old, in very good condition. Teletype Model 43: $450. TI Model 745: $500. Tom Radi, (714) 947-3440.

FOR SALE: BYTE September 1975 to February 1979 (January 1976 issue missing): $125. Also, first 14 issues of Kilobaud Microcomputing: $35. All in mint condition, shipping included. William Bates, 2246 Connell Terrace, Baldwinsville, NY 13027.

FOR SALE: Sinclair ZX80 with 1K RAM, 4K BASIC ROM. Comes complete with cassette and TV cables, power supply, TV connector, and manual. Includes software cassette with various programs: $85. Michael Kuchta, 166 Meriden Ave., Southington, CT 06489.

FREE: Electronic components and subassemblies; approximately 300 lbs. of recent vintage parts for donation to a qualified nonprofit organization. Also, BYTE Vol. 1, numbers 1, 4, 13, and 14; Vol. 2, number 1 through current: best offer. 55 issues of Interface Age Vol. 2 through 7: best offer. Ray Robertson, 7 Mechanic St., Dover, NJ 07801, (201) 361-1221.

FOR SALE: One RCA VIP 4K RAM (1802 Cosmac) single-board computer with all documentation and the following boards: color, sound, expansion, tiny BASIC, and RCA keyboard; best realistic offer. Also, BYTE magazine issues between 1/78 and 11/82, best offer. Would also like to trade Atari 400/800 public-domain programs. Henry Will, 248 Perry St., Dover, NJ 07801, (201) 366-8366.

WANTED: I am looking for a serial interface for the Olivetti Praxis 35 electronic typewriter. It must be compatible with an RS-232C connection. Send your price for the interface. I will also pay a reasonable price for a tested schematic. Kenton M. Chun, 6580 Santona St. #38, Coral Gables, FL 33146.

FOR SALE: Hewlett-Packard HP-85 microcomputer with 32K main memory. HP 8-inch double-sided double-density disk drive. 2.36 million bytes permanent-storage drive unit includes HP-IB interface cable with all ROMS. Has full graphics, fast thermal printer, HP-85 carrying case, financial and standard paks: $6500. Carter Mebane, POB 1762, Wilmington, NC 28401.

WANTED: Used HP-7225 plotter, 85-13038 Graphics Presentation Pac, and 17601A Opt 085 Personality Module. C.B. Campbell, 222 Glenview Dr., Des Moines, IA 50312.

FOR SALE: Zenith Z-89 processor logic board (85-2208-1) with 64K RAM and latest ROMs, excellent working condition: $500. Three single-density disk I/O boards (85-2219-1) for Heath/Zenith H-/Z-89: $50. N. McLarin, West 507 Euclid, Spokane, WA 99205, (509) 328-4185.

FOR SALE: Zenith 19-inch monitor (CV1950) with RGB, video, and audio inputs. Used once: $400. Also, a Commodore KIM-I, Godbout II 8K memory, and documentation: $200. Marvin Green, 22262 Southwest Stafford, Tualatin, OR 97062.

FOR SALE: Tektronix 4014-1 19-inch high-resolution graphics terminal. As is: $400 or best offer. Steve Ligett, Dairy Hill, South Royalton, VT 05068, (802) 763-8894.

FOR SALE: Intertec Compustar Model 10, 64K intelligent terminal, still in factory box; list $1300, sale price $500. Bill O'Neil, 806 Parma, Coral Gables, FL 33146, (305) 532-1761.

FOR SALE: Vector Graphic System-B complete with extensive software. Z80, 64K, two Micropolis 320K drives, and a Hayes Micromodem. CP/M 2.2, ASM, Scope, MBASIC-5, FORTRAN, Peachtree Accounting, Memorite III word processing, Execuplan II and Scratchpad spreadsheets, dBASE II, Microstat statistics, Statgraph graphs, Crosstalk comm, and others; also, 100-plus Memorex disks. First-quality system for serious computing: $3250. Leons Kovisars, Suite 112, 445 Union Blvd., Lakewood, CO 80228, (303) 989-7906.

FOR SALE: TRS-80 Color Computer, Extended Color BASIC, 32K. All original equipment plus joysticks, recorder, dust cover and software available in cartridges and cassettes. Extras, like new, hardware alone: $725. Total value over $1000, asking $500. Will negotiate. Mike Smith, 2457 Pioneer Rd., Evanston, IL 60201, (312) 869-9829 after 6 p.m. CT.

FOR SALE: Netronics ELF II microcomputer trainer, two 4K memory boards, giant board, and kluge board. Software on cassette: ELF-BUG monitor, tiny BASIC, assembler, disassembler, and text editor. Documentation includes RCA 1802 users manual, short course on tiny BASIC, all schematics, and additional software. All in excellent condition. Worth over $500, best offer. Robert Widlicka, 1420 Plain #1, Las Cruces, NM 88001, (505) 522-3075 or 646-4401.

FOR SALE: Liquid-pipeline program for HP-41C calculator. Computes pressures and horsepower required at each pump station for a multi-pump station pipeline. Allows for peaks and control points on pipeline profile. 50 pairs of profile points and 10 pump-station locations can be input. Output can be formatted to print suction and discharge heads for plotting hydraulic gradient. Magnetic cards with documentation: $30. Shashi Menon, P.E., Box 2533, Corona, CA 91720

WANTED: SS-50 disk controller (preferably GIMIX #58 or #48) and DOS (Flex 2.0) for 6800. Send details and price. Charlie Hoffpauir, 2603 Perry Lane, Alvin, TX 77511.

FOR SALE: ASR 33 Teletype with acoustic coupler: $400. Commodore 8096 96K (with UCSD Pascal compiler): $1600 Commodore 9000 Super PET with BASIC, FORTRAN, APL, Pascal, assembler: $1600. Commodore 8050 dual disk drive and controller: $1400. Epson MX-100 printer with Graftrax and IEEE interface: $800. Software free with above computers: business programs, games, and more. Andrew Ring, 267 Middle Rd., Yarmouth, ME 04096.

WANTED: All kinds of programs in French for the Apple II or CP/M 8-inch. Exchanges are also possible. Bob Grattan, 107 Howard St., Ashland, VA 23005.

FOR SALE: Graduate student who owns a Sinclair ZX81 with 64K module has over 500 programs available to sell, trade, etc. Would also like to exchange tips and information. Programs are predominantly oriented for business, household, and games. Craig Passman, POB 4131, Hammond, LA 70402.

FOR SALE: Digital Group System 5: Z80, 32K, two 8-inch disk drives, full keyboard, 9-inch monitor, printer/audio-visual interface, CP/M-compatible, MCOZ MaxiBASIC, Opus, CBASIC, utilities, and software: $2750. Sandor Valner, Cafetos 51, DF 11700, Mexico, (905) 596-2782.

WANTED: Documentation and software for Wang 2200-WS-F4A S/N EF-2064. Will pay reasonable charge for original or duplicate copy or I will provide deposit while I copy. Jim Elrod, 3315 Birch Creek Dr., Kingwood, TX 77339, (713) 358-0024.

FOR SALE: Intel 8051 single-chip microcomputer System Design Kit (SDK-51) with complete hardware reference manual, monitor listing, and 8051 assembly-language programming manual. Originally $1200 from Intel. Make an offer: check or money order. Tom Lee, Apt. 8, 633 South 8th St., San Jose, CA 95112, (408) 946-3000 ext. 501 days and 294-0507 evenings.

FOR TRADE: SwTPC system boards: MPA2 motherboard, 6800 with Percom 6809 adapter, 6845 video-graphic board, 64K dynamic memory board, MPLA. All populated except memory board. Will trade for 5¼-inch disk drive or printer. R. Naud, 637 Cameron Ave., Windsor, Ontario N9B 1Z7, Canada.

FOR SALE: SwTPC 6800 with two 16K and three 4K RAM, serial/parallel, control and clock/calendar boards. MF-68 disk-interface board, Microtek MT80P printer, Microterm ACT-1 terminal, and disk software: $900 or best offer. Will sell individual items; send for complete list. Jim Hall, 2063 108th Ave., Otsego, MI 49078, (616) 694-9760.

FOR SALE: Ohio Scientific C4P with minifloppy. Color graphics, sound, modem and printer ports, PIA ports, all necessary cables, and assorted disks complete with operating system. Also, various game and utility programs. Best offer takes all. Andrew Hunt, 34 Sans Souci Dr., Pawling, NY 12564, (914) 855-1073.

FOR SALE: Commodore 2022 tractor-feed printer. Uppercase and lowercase, PET graphics, expanded characters, and formatted lines. Includes PET to IEEE cable, manual, and several programs: $495. John E. Barnes, 13 Alcott Dr., Wilmington, DE 19808, (302) 772-4085 days, 994-7831 evenings.

WANTED: Self-study courses on computers by Sybex, Heathkit, or NRI. Should be complete and in good condition. Send description of course and price. Dan Williams, POB 1321, Collegedale, TN 37315.

FOR SALE: BYTE: 24 issues from 1978 to 1980. Interface Age: 4 issues from 1977 to 1978. Kilobaud Microcomputing: 22 issues from 1978 to 1980. Computer Notes: 3 issues from 1977. Creative Computing: 1 issue from 1977. ROM: 1 issue from 1977. Personal Computing: 1 issue from 1979. Best offer. Norman Rabek, Rt. 2, Box 56, Burnsville, NC 28714.

FOR SALE: Osborne 1 including all software: $1500. Also, Epson MX-80 III FT printer and cable: $550. Prices include shipping and insurance. Used only a few months. Thomas Bailey, 1626 Adams Ave., San Diego, CA 92116, (619) 296-6801.

FOR SALE: OSI C24P++ with 6502 at 2MHz, 24K RAM, expandable to 48K, 8-inch disk drive, OS-65D V3.3 DOS, 32 by 32 or 32 by 64 video display, 256 by 512 effective screen resolution, RS-232C, and two OSI I/O buses for additional external I/O. Also, EPROM programmer, high-speed analog I/O, home security or AC remote-control systems and lots of software. System works fine; in very good condition. Paid over $2200, will sell for $1200 or best offer. Tom Grant, 4343 Old Fort Rd., Klamath Falls, OR 97601, (503) 883-2826.

FOR SALE: SSM VB3A video board for S-100 bus with 80 by 24 display, many screen attributes, and graphics. Includes disk of software drivers for intelligent terminal emulation for VB3A from SSM. A little over 1 year old, perfect working order. Cost $490 new, $375 or best offer. Howard Spindel, 20877 Southwest Winema Dr., Tualatin, OR 97062, (503) 692-5778.

FOR SALE: Two Tandon TM-100-1 drives mounted in an external cabinet including power supply: $400 or best offer. IBM 64K memory board: $200 or best offer. Terry Sellick, POB 649, Belvidere, IL 61008.

WANTED: Public-domain CP/M 2.2 utilities, etc., and 8080 ASM source code, if possible. Will pay reasonable copying and handling charges. Will also swap what I have. Need North Star 5¼-inch format, DS/DD preferred. Send description and usage with any known bugs. Philip Bond, 27 Sharon Dr., Spring Valley, NY 10977, (914) 425-2550 evenings.

WILL SHARE: Apple II software found useful by a school guidance/counseling department. Includes information on selecting a career, commercial programs helpful to counselors, and has storing, retrieving, and sorting capabilities. Send large SASE for information. Keith L. Drieberg, Guidance Dept., Auburn Adventist Academy, 5000 Auburn Way South, Auburn, WA 98002.

FOR SALE: Two years of BYTE magazine, numbers 1 through 24. Good to excellent condition. Best offer. John Steiner, 508 4th Ave. NW, Riverside, ND 58078, (701) 282-0293.

WANTED: 6809 Flex user would like to correspond with other users to exchange programs and ideas. Need business applications, games, scientific programs, and control applications. I have several disk utilities running under TSC Flex. C. S. Severin, POB 2023, Beaverton, OR 97075, (503) 646-1545.

FOR SALE: IMSAI 22-slot, S-100 system with 28-amp supply, front panel, Cromemco ZPU processor board (Z80 has 2 or 4 MHz), SDS Expandoram with 48K installed, Wameco EPM-2 EPROM board for 2708s or 2716s, Godbout #106 active terminator board. Also, original IMSAI 8080 processor and 4K RAM boards. All in working order with original boxes and manuals: $700 plus postage. Tom Lowery, Rt. 2 Box 706, Georgetown, KY 40324, (502) 863-6165.

FOR SALE: Compucolor II, 16K RAM (expandable), screen refresh RAM, 27K system ROM including BASIC, built-in 5¼-inch floppy-disk drive, built-in high-resolution color monitor, 128 by 128 eight-color graphics, 32 by 64 ASCII, uppercase and lowercase, sound board, RS-232C port, and a 101-key keyboard. Software includes Star Trek, database, chess, income tax, sound effects, music, etc. Complete manuals and schematics. Operating system listing. Originally over $2000, will sell for $599. Vick Bennison, 2 Georgetown Dr., Amherst, NH 03031, (603) 673-9073.

FOR SALE: TRS-80 Model I, 16K, Level II, tape system with 42 tapes of $300 worth of software: assembler, debugger, people's Pascal, Basex compiler, Dunjunquest, Asteroids, Microchess, FS1 Flight Simulator, Typing Tutor, The Game of Life, and more. $650 or trade for Apple. Fred Stahl, 14872 Sycamore Manor Dr., Chesterfield, MO 63017, (314) 532-7799.

FOR SALE: SwTPC 6800, 8K RAM, MPS, MPLA: $200. Thomas Video RAM: $75. Jameco keyboard with case: $110. DC3 Disk Controller: $150. 64K dynamic RAM with 64K: $360. AC30: $40. CT-64: $75 as is. Ray Utter, Box 5207, Virginia Beach, VA 23455.

WANTED: A deal on a good quality printer with suitable interface, allowing it to run with Commodore PET 4032 and Paper Mate word processor. Correspondence or letter quality OK. M. Billik, 412 Hollybrook Dr., Midland, MI 48640, (517) 631-7607, weekends or after 5 p.m. on weekdays.

FOR SALE: Onyx 20 MB hard-disk computer, almost new, in perfect condition. Two Televideo 950 terminals with a detachable keyboard. One Diablo 630 Printer. R. W. Peterson, (504) 387-1463.

FOR SALE: SOROC IQ-170, mint condition, just burned in: $550 or best offer. David Fiori Jr., 13 Bellvue Ave., Penndel, PA 19047, (215) 752-4101.

WANTED: I am trying to find chess programs which run on CP/M 2.2 with no graphics (Televideo 950 terminal). Please send specs, documentation, and cost of your software (for 8-inch floppy). A. B. Muller, 793 K Tramway Lane, Albuquerque, NM 87122.

UNCLASSIFIED POLICY: Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial (individuals or bona fide computer clubs only), typed double-spaced on plain white paper, contain 75 words or fewer, and include complete name and address. This service is free of charge; notices are printed once only as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least three months for your ad to appear. Send your notices to Unclassified Ads, BYTE/McGraw-Hill, POB 372, Hancock, NH 03449.

Unclassified Ads

FOR SALE: Anderson-Jacobson Model 841 I/O communicating Selectric teletypewriter, RS-232C cable included. Excellent condition; prints ASCII text at 14.5 cps. Asking $800. Will consider trade for Epson dot-matrix printer, preferably MX100. John Kennedy, 3300 Carriageway Dr. #402, Arlington Heights, IL 60004, (312) 322-6039 or 577-2282.

WANTED: Atari 400/800 owners who would like to swap programs and conversation about computers, science fact/fiction, electronics, etc., by cassette tape. Will also tape for conversations with other computer buffs. Bill Wheat, Apt. 1103, Arrowbend Dr., Williamson, NY 14589.

FOR SALE: SSM CBIA and SSM I/04. Both boards have sockets and other components installed, but have few integrated circuits, $60. Greg Bober, 20126 Doyle Court, Grosse Pointe Woods, MI 48236, (313) 884-2133.

FOR SALE: HP-85A computer with the following options: 16K RAM module, HP-IB interface, 5¼-inch floppy disk and controller, 12 software pacs including Visicalc Plus and Graphics Pac. Also includes ROM drawer and following ROMs: I/O, Advanced Pgm, Mass Storage, Matrix, Assembler, and Plotter/Printer. Less than one year old. Asking $4500. Garry Derbyshire, 220 East Mermaid Lane #115, Philadelphia, PA 19118, (215) 242-3138.

FOR SALE: 192K bytes of DEC core memory (MF-11 Lp), with all control boards, three backplanes, cables, and documentation. Each backplane holds 64K bytes. Memory in perfect working order and still under DEC maintenance. Over 40 boards in all, including spare 8K memory core. Came out of PDP-11/50 (fits 40, 45 also). Lists for $250 per 8K words. Used price, $1000. Charles Viau, 424 Commercial St., Braintree, MA 02174, (617) 848-3669 evenings.

WANTED: People interested in sharing ideas about the Commodore VIC-20. The possibility exists of forming a user group to span the continent. D. Piette, 2351 Workman, Montreal, Quebec H3J 2N3, Canada.

WANTED: Video Brain Computer (Umtech) with APL/S cartridge. Also, Video Brain peripherals (Expander 1 cassette interface, Expander 2 modem, printer, joysticks, cartridges, etc.), schematics, manuals, or any information on where I may obtain these items. Correspondence from Video Brain owners or user groups welcome. Please send list of hardware and software with reasonable price information. Patrick King, Box 14165, San Antonio, TX 78214.

NEEDED: Statistical programs: general statistics, analyses of variance and regression, nonparametric statistics, pharmacokinetic programs, etc. to be run on a Sirius computer under either CP/M, MS-DOS or CP/M-86. Nils G. Svedmyr, Viktor Rydbergsg. 48/357, S-412 81 Goteborg, Sweden, Tel. +46 31 204576.

FOR SALE: Two Anderson Jacobson 1245 coupler/modems. Bell 103 and Bell 202 modes, (300-bps full duplex and 1200-bps half duplex). These were $700 each new, will sell for $350 each. Alan Selfridge, 2592 Middlefield Rd., Palo Alto, CA 94301, (415) 327-1140.

WANTED: I own a Sinclair ZX81, and would like to trade information with other ZX81 owners. Greg E. Sedbrook, 1004 East 2nd, Del Rio, TX 78840.

FOR REPAIR: Printed circuit boards for Qume Sprint 3 (45,55 cps); Sprint 5; Diablo Hytype II; and Diablo Model 630. Also, Sprint 9 (45,55 cps) carriage, assembly, and motor encoder. Please quote a price for repair. Don Kim, 5515 Livingston Rd., Oxon Hill, MD 20745, (301) 567-0365.

FOR SALE: Two Helium-Neon Lasers. 2-milliwatt visible red output. $100 each or will trade. Electronics and laser knowledge required for safe operation. Jim Bonner, 1005 North Dickson St., Tuscumbia, AL 35674, (205) 383-1844.

FOR SALE: IBM Selectric printer purchased as a Datel 1035 terminal. It includes a printer (which also doubles as a Selectric typewriter), complete Datel and IBM documentation, and an EPROM set and documentation to convert from correspondence code to parallel ASCII. $425. Gene Nelson, 74 Brant St. #4, Amherst, NY 14226, (716) 835-8997 or 831-2328.

NEEDED: Physics teacher needs Persci 277 disk drive in working condition. W.C. Johnson-Chamberlain, Craven Community College, Box 659, Beaufort, NC 28516.

SURPLUS: Sinclair ZX81 owners, 32K memory boards with four I/O ports, $12. Board, 46-pin connector, and schematic: $16. D.L. Beduhn, 411 Clancey Lane, Stoughton, WI 53589.

FOR SALE: Synetix 2022 294K double-drive RAM disk emulator for Apple II, new with warranty, software for DOS 3.3, Pascal, and CP/M: $795. Apple grayscale low-resolution luminance board (see 11/82 Comp & Elec/PE) assembled and tested with software: $100. Michael Gilbert, 73 Spaulding St., Amherst, MA 01002, (413) 253-2786.

FOR SALE: Rockwell AIM-65, 28K of static RAM, plus assembler and PL65 PROMs, all documents, one year old: $425. Ron Dail, 63 Maplewood Ave., Cranston, RI 02920, (401) 943-7408.

FOR SALE: Doublevision 80-column card for Apple II, with Doublevision version of Apple PIE 2.0 word-processing software: $200. Also, Integer BASIC firmware card: $50. Dr. Steven Souza, Department of Physics and Astronomy, Williams College, Williamstown, MA 01267.

FOR SALE: Intelligent Systems Corporation color-graphic computer systems: Compucolor II with 16K user memory, 5¼-inch disk drive, and 72-key keyboard. Intecolor 3651 with 32K user memory, 8-inch disk drive, and 117-key keyboard. Common components for above systems: 8-color/13-inch RGB display, Disk BASIC/FCS (DOS) in ROM, RS-232C interface, extensive software, and complete documentation. Will pay insured shipping inside U.S. Darryl Nadvornick, 14818 Elaine Ave., Norwalk, CA 90650.

WANTED: Zilog ZDS 1/40 Development system number 05-6013-06. Please send price and full details. Willy Adams, 52 Boerderijstraat, 8730 Harelbeke, Belgium; Tel. 056/ 223117.

FOR SALE: OSI 8K Superboard computer, 4.5A power supply, RF modulator and programs: $300. Studio II video game and cartridge: $30. Tom Rezachek, 6337-82nd St. S, Cottage Grove, MN 55016.

BOMB

BYTE's Ongoing Monitor Box

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Apple Shines

Apple created quite a stir in the microcomputing world long before it officially announced the Lisa and Apple IIe. Evidently these new products generated just as much interest among BYTE readers. Gregg Williams won first place in the February BOMB contest for his Product Description of "The Lisa Computer System." As a staff member he is ineligible for the $100 prize. Second place goes to Robin Moore for his review of "Apple's Enhanced Computer: The Apple IIe." He will receive the $50 award. Chris Morgan, Gregg Williams, and Phil Lemmons earned third place for their interview with three key members of Apple's engineering team: "An Interview with Wayne Rosing, Bruce Daniels, and Larry Tesler."

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